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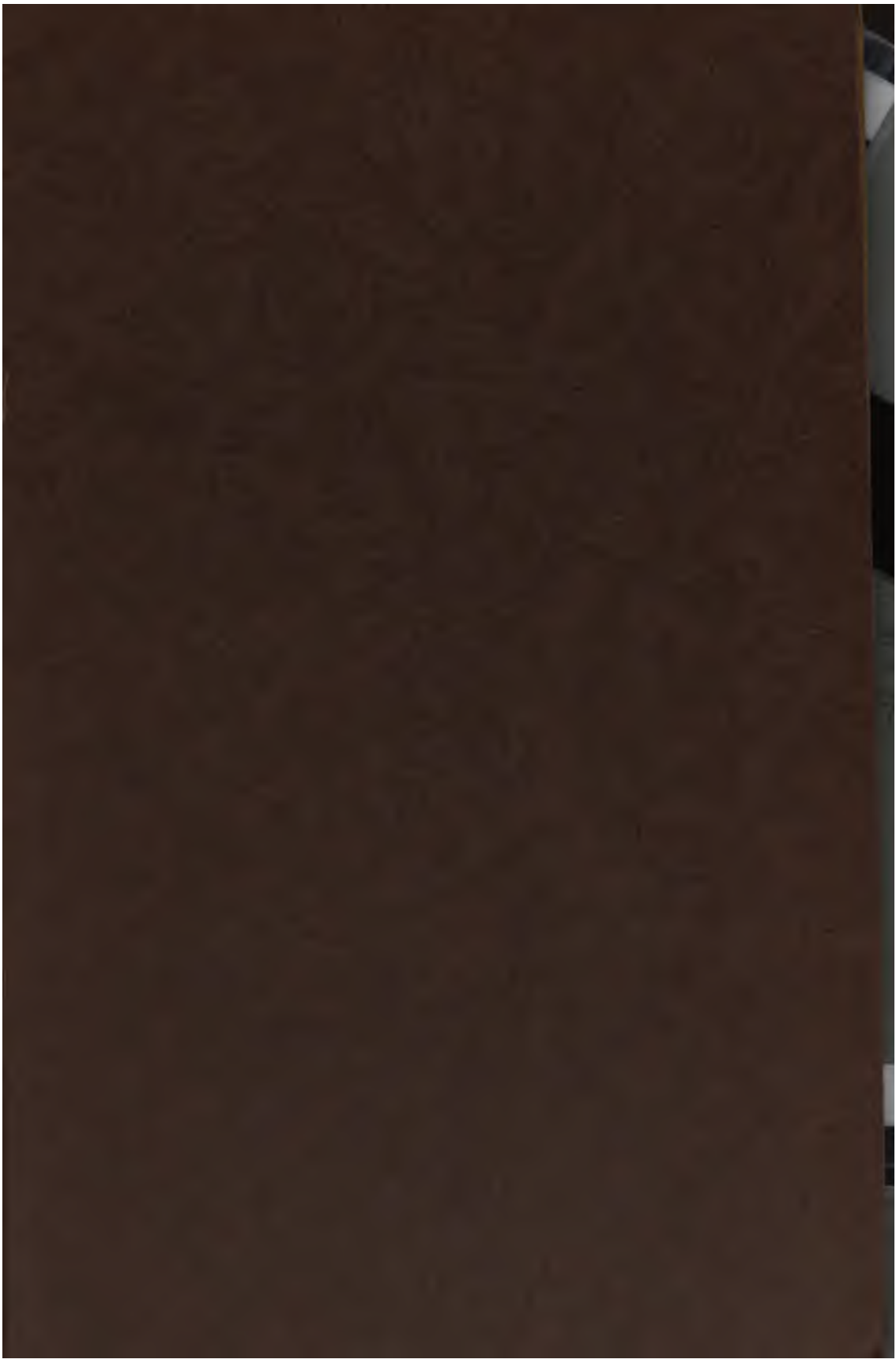

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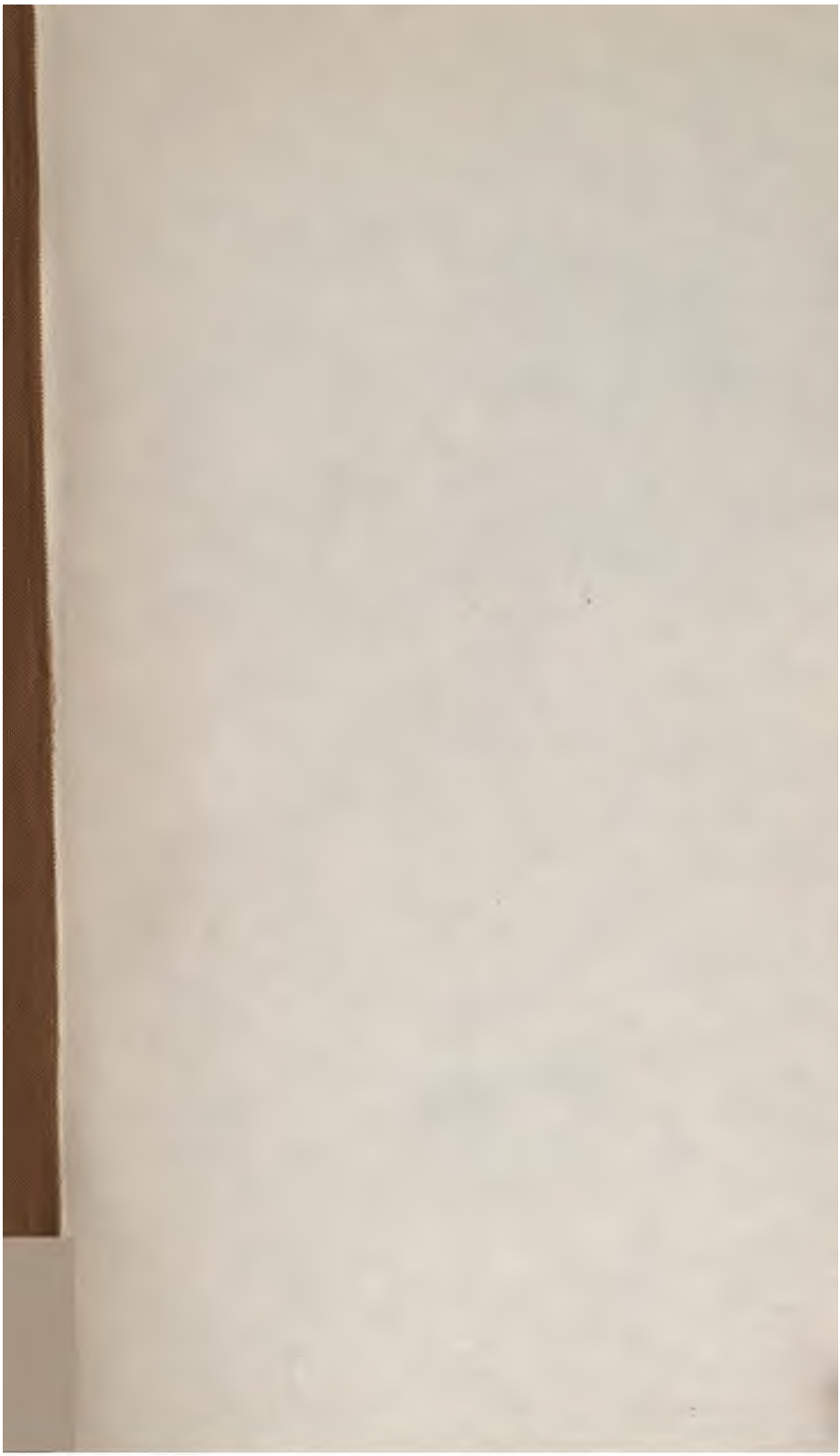

REPORT

UPON A

SYSTEM OF SEWERAGE

FOR THE

City and County of San Francisco

PROPOSED BY

C. E. GRUNSKY, CIVIL ENGINEER IN CHARGE

MARSDEN MANSON, C. S. TILTON,

ASSOCIATE ENGINEERS

APPROVED BY

RUDOLPH HERING, CONSULTING ENGINEER

SAN FRANCISCO:

THE HINTON PRINTING CO., 321 SACRAMENTO STREET,

1899

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In this printed copy of the report, the tables and diagrams have been rearranged, combined and amplified, and slight corrections in the text have been made where necessary.

REPORT

UPON A

SYSTEM OF SEWERAGE

FOR THE

CITY AND COUNTY OF SAN FRANCISCO.

San Francisco, October 21, 1899.

To the Honorable the Board of Supervisors
Of the City and County of San Francisco—

GENTLEMEN: In accordance with the requirements of your Resolution No. 3386 (Fourth Series), the sewerage problems of San Francisco have been carefully studied, and results can now be presented. The report herewith submitted contains a discussion of the method of disposal and best points of outfall, and describes the proposed method of collection for all portions of the City.

The accompanying plans and diagrams illustrate the proposed work. An estimate of the cost of works now needed and recommended for immediate construction is contained in the report.

The thanks of the City are due to the assistants in this work, who, notwithstanding uncertainty as to the power of the City to meet the financial obligations incurred, and the great delay involved in determining questions of finance, have faithfully served the City.

The work in hand is not to be considered terminated with the filing of this report. Many other diagrams are in the course of preparation which will illustrate the project further. These are to be completed and prepared for publication as speedily as possible. Much also remains to be done in the matter of adding to the records, which will be turned over to the City.

At the close of the work a financial statement will be submitted.

Very respectfully,

C. E. GRUNSKY,
Civil Engineer.

INTRODUCTION.

The location of San Francisco and its topographical features, as well as the conditions which now prevail, and which are to be ameliorated by systemizing the collection and disposal of sewage in this City, are fully described and set forth in the Report of the Engineers in Charge to Devise a Sewer System (See Municipal Reports of 1892-93, pages 273-310, and 1893-94, pages 931-937), and need not now be referred to in detail. It will suffice to say that for forty years the sewers have been constructed with an almost complete disregard of volume of sewage to be disposed of. They do not form a part of a system; there is not even an attempt, except in a few outlying districts, recently sewered, to effect gradual convergence to main lines of sewers, but up and down hill, through the length of each street, the sewers extend, cutting through each other at street intersections, and making it absolutely impossible to outline the districts which are tributary to mains. The flow to the main sewers very often depends upon the accidental degree of obstruction in the various laterals, and the area which they serve varies with the location of the obstruction.

Passing over the local defects resulting from the construction of sewers, a block or a crossing at a time, on a "hit or miss" sort of plan, with often an absurd adherence to the requirement that sewers must be ten feet below street grade, and the consequent disregard of the fact that there should be a continuous, even though broken, slope down hill, it is to be added that the sewers discharge wherever they happen to reach the water front or an open waterway. The foul condition of the Bay frontage is known to everybody. The open water way of Channel street, as a former Health Officer, Dr. Henry Gibbons, Jr., in 1874, put it, "smells to Heaven with a loudness and persistence that the strongest nostrils may not withstand and the disinfectants of a metropolis could not remove."

Into the sewers of the low-lying districts of the City east of Montgomery street, as well as south of Market street, the tides ebb and flow, causing continual annoyance, and occasionally no little damage, by the inability of the sewers to properly serve

basement fixtures and by the occasional cellar inundations to which they give rise.

To remedy these conditions, and to prevent their being extended into other low-lying districts, and to design sewerage systems for the out-lying districts of the City, is the problem now to be dealt with.

Under the urgent advice of His Honor, Mayor Jas. D. Phelan, the Board of Supervisors decided, in May of this year, to take up the matter where it had been left in 1893.

The necessity for prompt action in this matter lies in the fact that if the question of a bond issue for sewer construction purposes be not submitted to a vote before the close of 1899, all proceedings relating thereto would have to be taken under the provisions of the New Charter, which goes into effect with the New Year, and it would in that event be extremely unlikely that any tangible results would be obtained within the next three or four years. By settling the question of a bond issue this year, money for these much-needed improvements will speedily be made available, and the new Department of Public Works can at once undertake their construction.

The work to be done was defined in Resolution No. 2764 (Fourth Series) of the Board of Supervisors, from which the following clauses are quoted:

"Resolved, That this Board hereby appoints C. S. Tilton, C. E. Grunsky and Marsden Manson, Civil Engineers, whose duty it shall be to prepare and submit plans and estimates of the expense to be incurred, and to what extent it is necessary to correct the defects and inefficiencies of existing sewers, and to prescribe the salient features of the systems required for districts not now sewered.

"First. To determine the method of sewage collection and disposal, and the points of outfall.

"Second. To determine the location, size and character of the main sewers for each of the districts into which the City is divided by topographical features, and the mode of delivering district sewage to the points of outfall.

"Third. To recommend the order in which sewers and works should be constructed, and to designate those which should be constructed at once, with a plan of the same.

"Fourth. To make an estimate of the cost of constructing the main sewers and works suggested for immediate construction, which plans and estimate must be submitted and are hereby required to be filed with the Board on or before the 16th day of October, 1899."

This resolution was approved on May 12, 1899, and the duties imposed were accepted.

It was found, however, that there was an element of uncertainty in the matter of pay for services and expenses, which compelled the exercise of extreme economy preceding July 1, 1899, the commencement of the present fiscal year. There was every reason to hope and expect that there would after that date be no obstacle interposed to the energetic prosecution of the work, but after persistent inquiry it was finally found that, unless the form of the Resolution authorizing the work was modified, that it would not be recognized as legal by one of the City Departments, and that unfavorable action by that department would make it necessary either to seek interpretation of the Resolution by the Courts or to abandon the work. The delay necessarily involved in the former course would have been equally fatal to the work as the latter.

After delay upon delay, including the summer vacation of the Board of Supervisors, a new Resolution was finally passed, as follows:

"Resolution No. 3386 (Fourth Series).

"Whereas, This Board, contemplating permanent improvements, the cost of which will be too great to be paid out of the ordinary annual income and revenue of the municipality, is required to have plans and estimates of the cost of such improvements made prior to submitting the question of issuing bonds at a special election to the qualified voters of this City and County; and,

"Whereas, This Board hereby determines that the public interests demand the construction of main intercepting and outlet sewers and the reconstruction of many existing sewers, for the improvement of the sanitary conditions, and the protection of the health and property, and in the best interests of the people of this City and County;

"Resolved, That C. E. Grunsky, a Civil Engineer, who has had successful experience in such work, be and he is hereby employed to determine the method of sewage collection and disposal, and points of outfall; to determine the location, size and character of the main sewers for each of the districts into which the City is divided by topographical features, and the mode of delivering district sewage to the points of outfall; to designate those sewers which should be constructed at once, and to prepare plans and proper estimates of the cost for and of said contemplated improvements, and submit the same to this Board at the earliest practicable time, and at an expense not exceeding $20,000, inclusive of his own compensation, and he is further granted the free use of the rooms formerly occupied by the Architect of the City Hall in which to prosecute the work.

"Resolved, That Resolution No. 2764 (Fourth Series) be and the same is hereby rescinded and repealed.

"In Board of Supervisors, San Francisco, September 18, 1899.

"After having been published five successive days, according to law, taken up and passed by the following vote: Ayes—Supervisors Aigeltinger, Attridge, Black, Byington, Deasy, Heyer, Holland, Kalben, Lackmann, Perrault, Phelps. Absent—Supervisor Collins.

"JNO. A. RUSSELL, Clerk.

"Approved, San Francisco, September 21, 1899.

"JAS. D. PHELAN,

"Mayor and ex-Officio President of the Board of Supervisors."

As this Resolution was intended to merely correct the supposed legal defects of the original one, both Mr. Manson and Mr. Tilton were retained as Associate Engineers in the prescribed work.

It is therefore to be understood that, although the writer is in charge of the work of designing the sewers and estimating their cost, that both Mr. Manson and Mr. Tilton have remained connected with this work, and have participated in it to the same extent which they would have done under the original Resolution, and should therefore receive equal credit with the writer for the results now presented.

Very soon after the Resolution of May 12th was passed,

arrangements were made by the City to secure the services of Mr. Rudolph Hering, of New York, as Consulting Engineer, and advantage was taken of his presence here in June to examine into and discuss the local situation and to have the proposed general plan of treatment confirmed.

In October, when the work had been sufficiently advanced to bear further discussion, Mr. Hering made a final visit to the City, and after thorough investigation has given his approval to the project as now presented.

ENGINEERS AND ASSISTANTS.

The basis for the results now presented was laid in 1892-93 by the "Sewerage Commission," consisting of Col. G. H. Mendell, Prof. Geo. Davidson, Irving M. Scott, Marsden Manson and C. E. Grunsky, and by the "Engineers in Charge to Devise and Provide a Sewer System," Marsden Manson and C. E. Grunsky.

With the work this year the following have been connected:

C. E. Grunsky.....Civil Engineer in Charge.
Marsden Manson..... Associate Engineer.
C. S. Tilton..... Associate Engineer.
Rudolph Hering..... Consulting Engineer.
J. C. Henkenius.....Chief Draughtsman.
Burr Bassell..... Assistant Engineer.
Edw. F. Haas..... Assistant Engineer.
H. D. H. Connick..... Assistant Engineer.
H. D. Gates..... Assistant Engineer.
H. C. Behr..... Mechanical Engineer.
J. W. D. Jensen..... Draughtsman.
W. B. Prichard.....Assistant Engineer.
Peter Summerfield.....Assistant Draughtsman.
J. P. Morse..... Field Assistant.
Miss Mary J. Williams..... Typewriter and Stenographer.
W. D. Evans.....Assistant Clerk and Messenger.

Owing to the uncertainties in reference to this Department's financial affairs, the employes have not all served continuously.

DEFINITIONS.

Rainfall intensity—The rate at which rain falls, expressed usually in inches per hour, but preferably in cubic feet per second per acre of surface.

Run-off, or storm-water run-off—The surface drainage due to rain, representing the portion of the rain not absorbed by the surface on which it falls but reaching surface or sub-surface drains.

Drainage—The water, clean or foul, which flows from the surface or sub-surface of any area into a natural or artificial drain.

Sewage Proper—Water-carried house, domestic and industrial wastes.

Combined System of Sewerage—The system of sewerage in which sewage proper and storm-water run-off are carried in the same conduits.

Separate System of Sewerage—The system of sewerage in which sewage proper and storm-water run-off are carried in separate conduits.

Storm-water Conduit—A conduit for storm water only, or for the excess flow of the sewers during rainstorms.

Relief Outlet—An opening in the side of a sewer for the escape of waters in excess of its capacity.

Outfall—The point at which sewage is delivered for disposal.

Force Main—A pipe through which a pump discharges water or sewage under pressure.

Gradient—The inclination along the line of a water course or drain, being the quotient obtained by dividing the total fall by the length.

Hydraulic Gradient—The gradient of the surface of flowing water.

Sewer Invert—The inverted arch in the bottom of a sewer.

Range of Tides—Difference of elevation determined by the fluctuation of the water surface from low to high or from high to low tides.

City Base—The plane to which grades and elevations of the City are referred. It is defined as being 6.7 feet above ordinary high tide, and is about 12 feet above mean low, low tide of the Bay, and about 8.9 feet above the mean level of the Ocean.

LIST OF MAPS AND DIAGRAMS ACCOMPANYING REPORT.

Plate No. 1—Rainfall Frequency.

Plate No. 2—Rainfall Intensity; Limiting Curve, 0 to 24 Hours.

Plate No. 3—Rainfall Intensity; Limiting Curve, 0 to 60 Minutes.

Plate No. 4—Rainfall Rates.

Plate No. 5—Population.

Plate No. 6—Sewerage Districts and Sub-Districts, Mains and Sub-Mains of Combined Sewerage Systems, and Storm-Water Conduits of Districts Sewered on the Separate System.

Plate No. 7—Districts and Sub-Districts Sewered on the Separate System; Mains and Sub-Mains for Sewage Proper.

Plate No. 8—Profile of North Point Main and East Potrero Intercepter.

Plate No. 9—Profile of Fifth, Sixth, Seventh, Eleventh, Fourteenth and Fifteenth Street Sub-Mains, and of the Great Highway Sewer Leading to West Richmond Pumping Station.

Plate No. 10—Profile of Army, Channel and Brannan Street Sewers.

Plate No. 11—Profile of Hunter's Point Main Sewer.

Plate No. 12—Types of Sewers Now in Service.

Plate No. 13—Typical Sections of Proposed Sewers.

Plate No. 14—General Arrangement of Pumping Stations.

SEWERAGE SYSTEMS.

Not the least among the problems which relate to the maintenance of dense populations on relatively small areas, without menace to health and comfort, are those which deal with the disposal of waste of all kinds.

Sewage is the water-carried waste from the human body, from kitchen sinks, from industrial establishments and the like, and may be carried to points of disposal either with, or apart from, the storm water which drains from yards, roofs and street surfaces, and which also must be gotten rid of without unnecessary inconvenience and discomfort to the inhabitants.

When sewage proper is carried in conduits apart from those which carry storm water, the system of sewerage is called the "Separate System."

When sewage proper and surface drainage are admitted to the same conduits, the system of sewerage is called the "Combined System."

Both of these methods of collecting sewage are in successful operation in many American cities, and each is recognized as capable of fulfilling all sanitary requirements. It is not necessary, therefore, to enter upon a discussion of their respective merits. The sewers now in use in this City are conduits for both sewage proper and storm water. The project now recommended retains these in service, but such requirements as the keeping of the Ocean Beach free from pollution, and of improving the drainage facilities and sanitary condition of the low portions of the City, make it imperative to introduce a separate system to a not inconsiderable extent. The disadvantage of discharging sewage and cellar drainage against the high-tide stage of the sewers in the low Yerba Buena, Mission Flats and Islais Creek Districts, in the first of which the extensive wholesale business interests make complete cellar drainage particularly desirable, has long been felt; and the remedy lies in the restriction of the use of the present defective sewers to storm waters only, and the introduction of a deep-lying small-pipe system of drains for sewage only.

In Boston, where a large intercepting sewer with gravity outfall has this year been recommended for immediate construction to relieve the overburdened low-lying main drainage system, the matter of restricting the volume of flow to the new intercepter has been under consideration, and the Chief Engineer and Superintendent, Mr. Wm. M. Brown, Jr., says in this connection: "It is expected that the greater part of the district tributary to the high-level sewer will be sewered by what is known as the separate system of sewerage, by which the greater part of the rainfall is diverted into the ordinary channels, leaving the sewage from dwellings and manufactories, the leakage from ground water and a small portion of rain water to be conveyed in the sewers. Any draft of an Act which may accompany this report should provide that the separate system of sewerage should be used in all distinctly new sewerage districts."

(See "Report of the Metropolitan Sewerage Commissioners Upon a High-Level Gravity Sewer, for the Relief of Charles and Neponset River Valleys." Boston, January, 1899.)

The study of required capacity of each sewer involves careful consideration of all sources of sewage or waste waters which are tributary to it. The volume of sewage proper is usually and conveniently estimated on the basis of water consumption, because a large proportion of the water, after use in cleansing the human body, the wearing apparel, the utensils in, and the surroundings of our establishments and homes, becomes the carrier of the waste.

It is therefore necessary to make inquiry into the present and probable future water consumption of the City. It is also necessary to determine what amount of soil-water is likely to leak into sewers, because none of the materials of which sewers are usually made—concrete, brick or iron-stone pipe—will permit the making of an absolutely water-tight conduit. It is also necessary to study the weather conditions, particularly those relating to rainfall, and, on the basis of the rate of rainfall and character of the surface of the City, to estimate the volume of storm water run-off.

Information, in short, must be had:

First—Pertaining to the area and topographical features of each district, as well as the character of its surface.

Second—Pertaining to rainfall.

Third—Pertaining to population.

Fourth—Pertaining to water consumption.

Fifth—Pertaining to the probable inflow of soil water into the sewers.

RAINFALL.

The rainfall records of this City have been carefully studied in an endeavor to determine the maximum rainfall rate that must be used as a basis for calculating the volume of run-off. The records of the U. S. Weather Bureau, established in this City in 1871, commencing March 9th, have been of particular value. Preceding that date we have made use of a very carefully kept record by Thos. Tennent, who, as a manufacturer of nautical and scientific instruments, may be considered as specially qualified to obtain reliable results.

From these records it appears that from 1849 to 1899 rain was recorded in excess of 2.00 inches in 24 hours in this City on the following days:

January 29, 1850	2.20	February 20, 1867	2.12
December 17, 1852	3.00	February 21, 1867	2.22
December 25, 1852	2.54	December 18, 1871	2.83
January 7, 1853	2.06	December 19, 1871	3.12
March 27, 1853	2.85	December 23, 1871	2.48
April 16, 1853	3.45	January 8, 1872	2.36
March 13, 1854	2.25	November 29, 1872	2.06
October 21, 1858	2.06	November 23, 1874	3.98
March 26, 1861	2.53	November 17, 1875	2.30
December 26, 1861	2.02	March 5, 1879	2.73
January 5, 1862	2.67	January 29, 1881	4.67
January 9, 1862	3.50	December 23, 1884	2.01
January 10, 1862	2.46	November 23, 1885	2.58
January 16, 1862	2.46	December 21, 1885	*2.78
January 17, 1862	2.64	January 23, 1886	2.35
February 21, 1862	2.09	February 4, 1887	2.22
November 26, 1864	3.98	February 5, 1887	2.92
December 12, 1864	2.56	March 13, 1889	2.54
January 17, 1866	2.17	February 15, 1891	3.38
January 20, 1866	2.22	December 29, 1891	2.21
December 19, 1866	4.28	November 23, 1896	2.00
December 20, 1866	3.62	March 22, 1899	2.15

* In 11 hours.

The average number of rainy days in San Francisco per year is 66.

On forty of these it rains less than 0.25 of an inch.

On 26 days it rains more than 0.25 of an inch.

On 16 days it rains more than 0.50 of an inch.

On 9 days it rains more than 0.75 of an inch.

On 6 days it rains more than 1.00 inch.

On 2 days it rains more than 1.50 inches.

On 1 day it rains more than 2.00 inches.

It rains more than 2.50 inches per day only twice in every 5 years.

It rains more than 3.00 inches per day once in 6 years.
It rains more than 3.50 inches per day once in 10 years.
It rains more than 4.00 inches per day once in 25 years.
It rains more than 4.50 inches per day once in 50 years.

This is graphically indicated on Plate No. 1, showing frequency of rainfall in San Francisco. Horizontal distances in the diagram represent rainfall per day; vertical distances represent the average number of days per year on which the rainfall corresponding to any point of the curve is exceeded. The points indicated by small circles are determined by actual count based upon the records already referred to from 1849 to 1899.

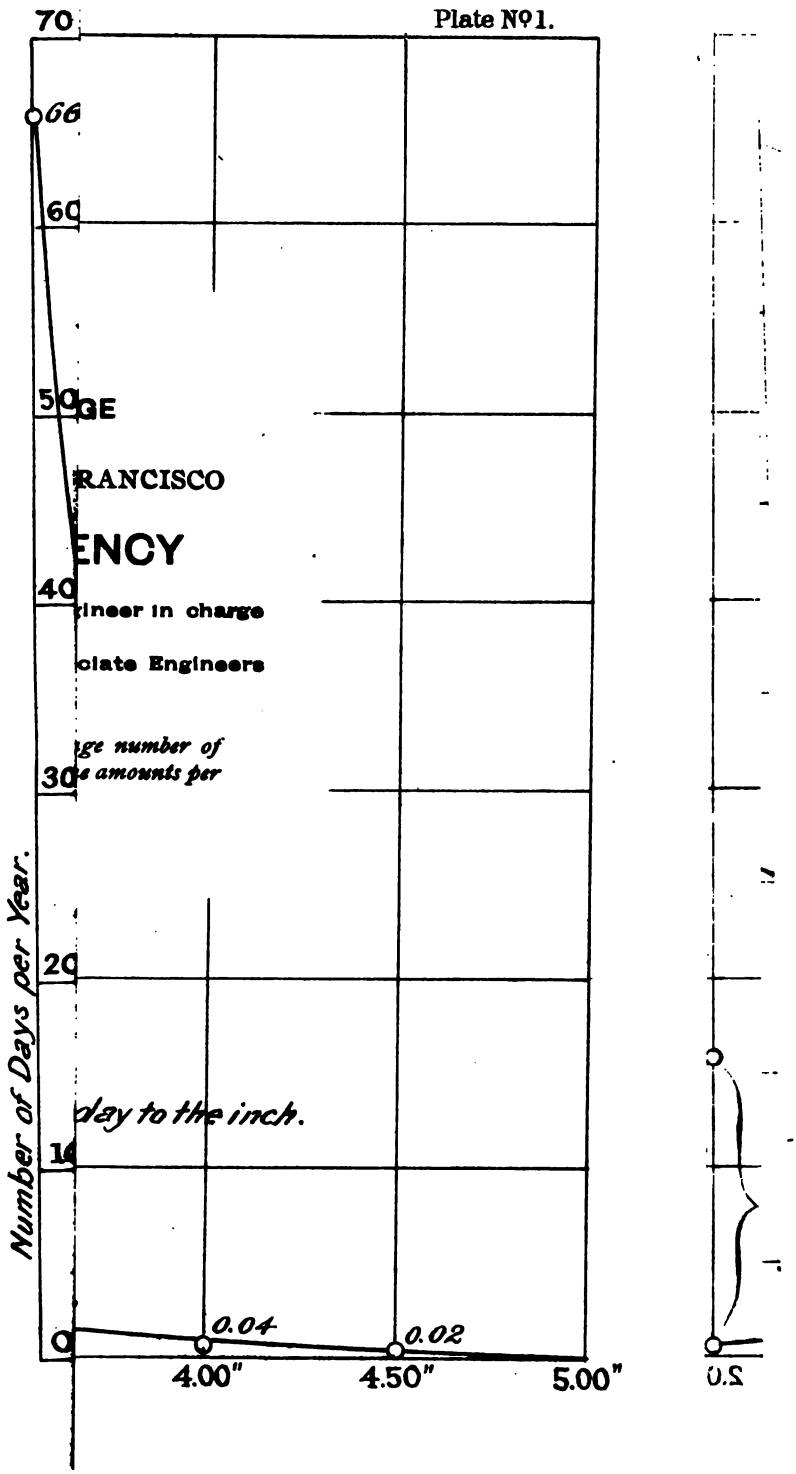
This exhibit is of value, first, because it proves how rarely excessive rainstorms are to be expected; second, because it shows that by far the greater number, nearly two-thirds, of our rainy days are days with less than one-quarter inch of rainfall. It also indicates that the occurrence of a rainfall in excess of 5 inches in 24 hours is highly improbable.

As a result of the special inquiry made by the "Sewerage Commission," and the "Engineers in Charge to Devise and Provide a Sewerage System," in 1892-93, the local Weather Bureau has exercised increased vigilance in studying and recording the rainfall intensity. It had been theretofore generally conceded that it never rained here 1 inch in an hour, and this seemed to be the limit of available information. Now, however, the additional fact has been established that since that year the greatest five-minute rainfall was 0.15 inch, on January 20, 1894, and the next 0.09 inch, on October 12th of this year, slightly in excess of that of November 23, 1896, recorded at 0.08 inch.

The greatest ten-minute rainfalls were 0.17 inch, on January 20, 1894, and 0.14 inch, on November 23, 1896. The greatest one-hour rainfalls were 0.55 inch, on November 23, 1896, and 0.36 inch, on January 20, 1894.

(From information furnished by A. G. McAdie, Local Forecast Official and Section Director in charge of U. S. Weather Bureau, San Francisco.)

Using this information, and the fact, which seems fairly well established, that the maximum rainfall in 24 hours may be assumed at about 5 inches, together with the record of 2.78 inches of rainfall on December 21, 1885, it was possible to construct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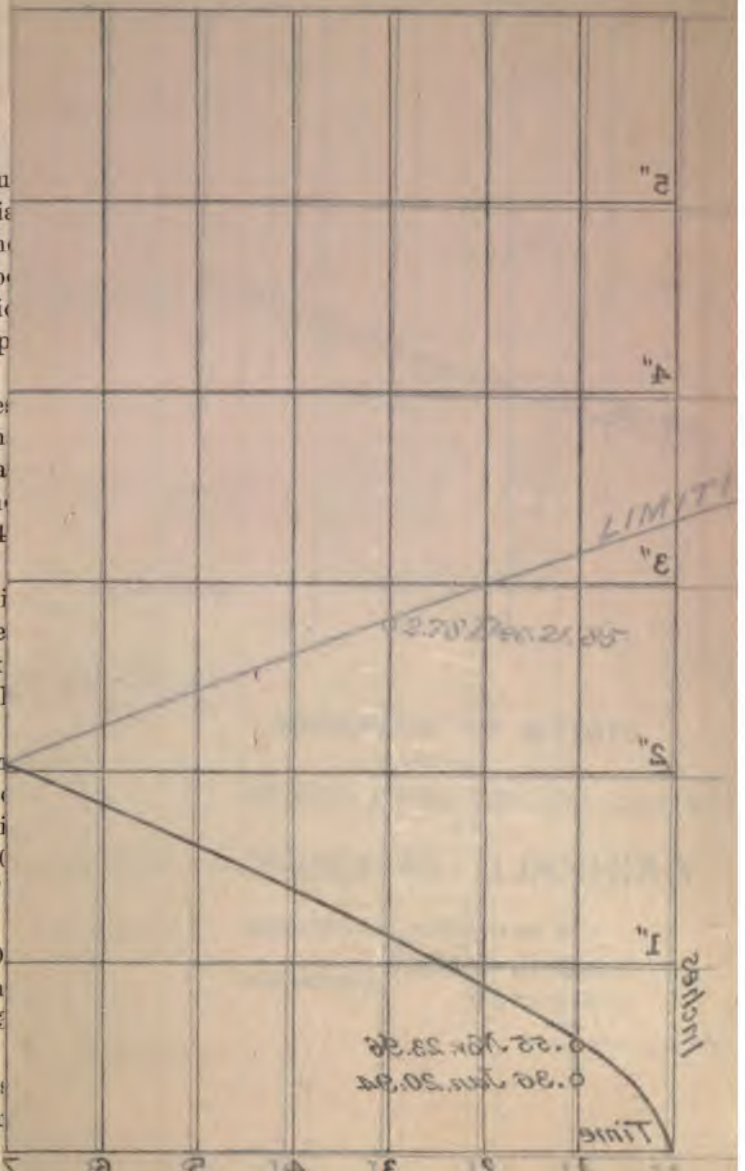
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2"
1"
Inches
Time

PLATE No. 3.

Rainfall Intensity, Limiting Curve, 0 to 60 Minutes.

limiting curves, as shown on Plates Nos. 2 and 3, the second diagram representing a portion of the first on an enlarged scale. These curves indicate the maximum cumulative rainfall for any time period from 5 minutes to 24 hours. The occurrence of rain in excess of the amounts indicated by these curves is highly improbable. There are no records, in fact, to show that they have ever been exceeded; but we must, nevertheless, deplore the absence of rate records for periods of one hour and less preceding 1893.

Interpreting these results, we note as the maximum amount of rainfall to be expected:

At the end of 5 minutes, 0.15 inches.
At the end of 10 minutes, 0.22 inches.
At the end of 20 minutes, 0.32 inches.
At the end of 30 minutes, 0.40 inches.
At the end of 40 minutes, 0.47 inches.
At the end of 50 minutes, 0.54 inches.
At the end of 60 minutes, 0.60 inches.
At the end of 2 hours, 0.90 inches.
At the end of 3 hours, 1.15 inches.
At the end of 6 hours, 1.83 inches.
At the end of 12 hours, 3.00 inches.
At the end of 24 hours, 5.00 inches.

The maximum rates of rainfall as determined from these aggregate amounts are as follows:

It may rain for 5 minutes at the maximum average rate of 1.80 inches per hour, equivalent to 1.80 cubic feet per second per acre.

It may rain for 10 minutes at the maximum average rate of 1.32 inches per hour, equivalent to 1.32 cubic feet per second per acre.

It may rain for 20 minutes at the maximum average rate of 0.96 inches per hour, equivalent to 0.96 cubic feet per second per acre.

It may rain for 30 minutes at the maximum average rate of 0.80 inches per hour, equivalent to 0.80 cubic feet per second per acre.

It may rain for 40 minutes at the maximum average rate of

0.70 inches per hour, equivalent to 0.70 cubic feet per second per acre.

It may rain for 50 minutes at the maximum average rate of 0.65 inches per hour, equivalent to 0.65 cubic feet per second per acre.

It may rain for 1 hour at the maximum rate of 0.60 inches per hour, equivalent to 0.60 cubic feet per second per acre.

This is represented graphically on Plate No. 4, in the diagram showing maximum rainfall.

In this connection the following extract from a letter dated June 23, 1899, by Thos. Tennent, is of interest:

"In reply to your inquiry concerning the rainfall in San Francisco, and what has been the greatest quantity which has fallen in a given time, say one hour, I will state that I have, personally, kept a record of the rainfall in this City from 1849 to 1896, measuring the quantity in each 24 hours at 8 A. M. On looking over my records" (preceding the establishment of the U. S. Weather Bureau, in March, 1871), "I find that the heaviest rainfalls we have had in 24 hours occurred, viz: 1864, November 26th, 3.98 inches, with the remark, 'Heavy rains in the morning; rain and gale at midday; steady rain P. M. and evening.' 1866, December 19th, 4.28 inches; 'heavy rain and gale in the morning; hail with thunder at midday; rain during the balance of the day and evening.' 1866, December 20th, 3.62 inches; 'high wind and cloudy in the morning; then a steady rain all the afternoon and evening.'

"I can state without hesitation, that we have never had a fall of rain of *one inch in any one hour.*"

STORM-WATER RUN-OFF.

The storm-water run-off in cases where there is no snow will never be fully equal to the rate of rainfall in any district, even when the entire surface is apparently roofed or covered with impervious pavement. So far as measured by competent authority, 90 per cent. may be noted as a maximum run-off for small, densely built up areas, and it has been found by practical experience, when fairly large areas of the business sections of cities are taken into consideration, that it is safe to assume that the maxi-

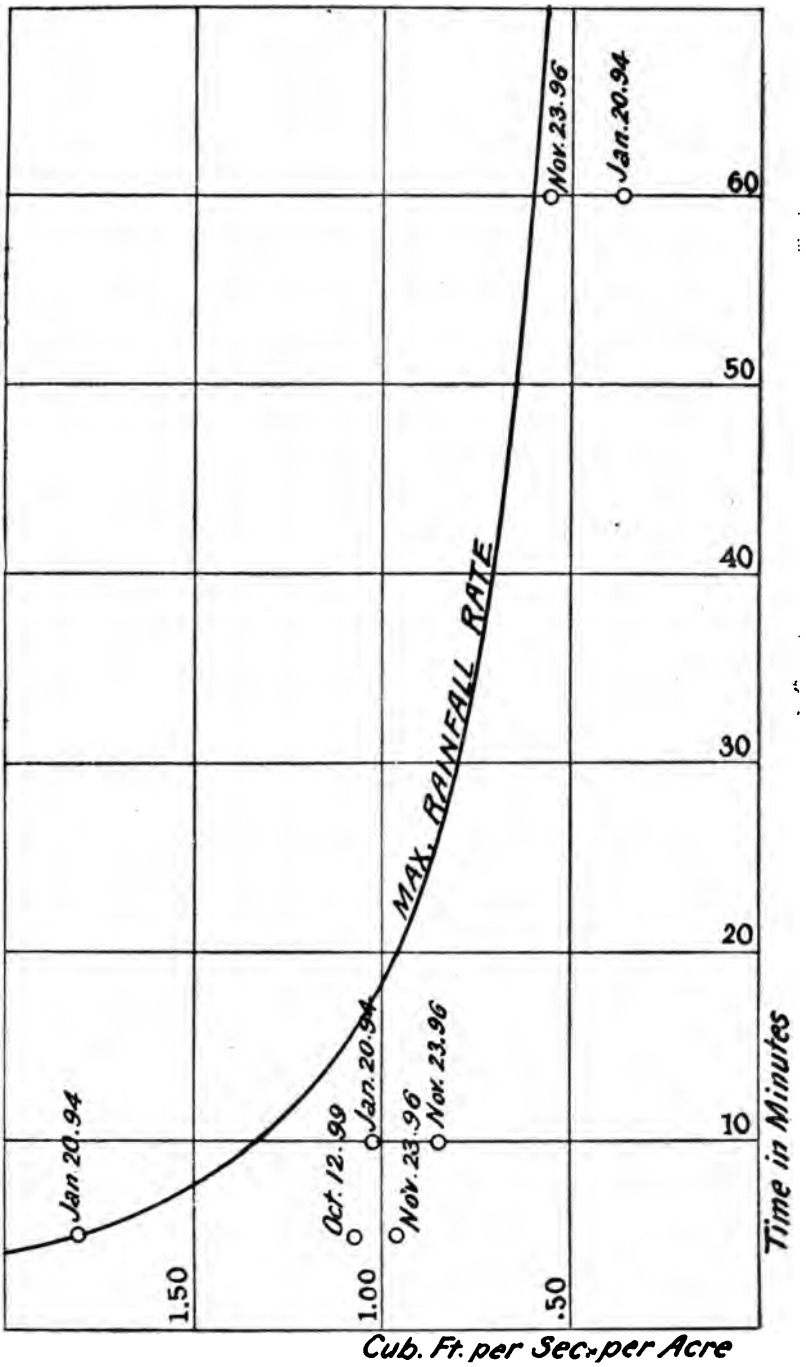


PLATE No. 4—Rainfall Rates.

mum run-off rate will not exceed 75 per cent. of the maximum rainfall rate.

In well-improved residence districts the percentage of run-off is about 60, and in suburban districts it falls as low as 30. These percentages, established by experience in older cities, have been used as a guide in making estimates of volume of storm-water to be handled. It was found convenient to take the steepness of the watershed, the character of the soil and density of population into consideration to some degree in determining the probable proportion of run-off for each district. No inflexible rule, however, could be laid down as a guide, and the percentages were often assigned somewhat arbitrarily.

Except for such arbitrary modifications, the following table was used as a guide:

Population per acre, 20; percentage of run-off, 30.
Population per acre, 30; percentage of run-off, 40.
Population per acre, 40; percentage of run-off, 50.
Population per acre, 50; percentage of run-off, 55.
Population per acre, 70; percentage of run-off, 65.
Population per acre, 80; percentage of run-off, 70.
Population per acre, 90; percentage of run-off, 73.
Population per acre, 100; percentage of run-off, 75.

RUN-OFF DETERMINATION.

In determining the maximum run-off to be expected from any district, the time was first approximated which it would take water to flow from the most remote sections of the district to the point at which conduit capacity was in question, an allowance of 3 to 5 minutes being made for water to reach the conduits. The rate curve was then used to establish the maximum rainfall that is likely to prevail for that length of time. All parts of the district were then assumed to be contributing run-off waters to the conduit resulting from a rainfall of that intensity. As this intensity is expressed in cubic feet per second per acre, the calculation became very simple. No account was taken of the volume of flow, nor of the time required to completely fill the conduits, it being thought proper to utilize these elements as a further factor of safety.

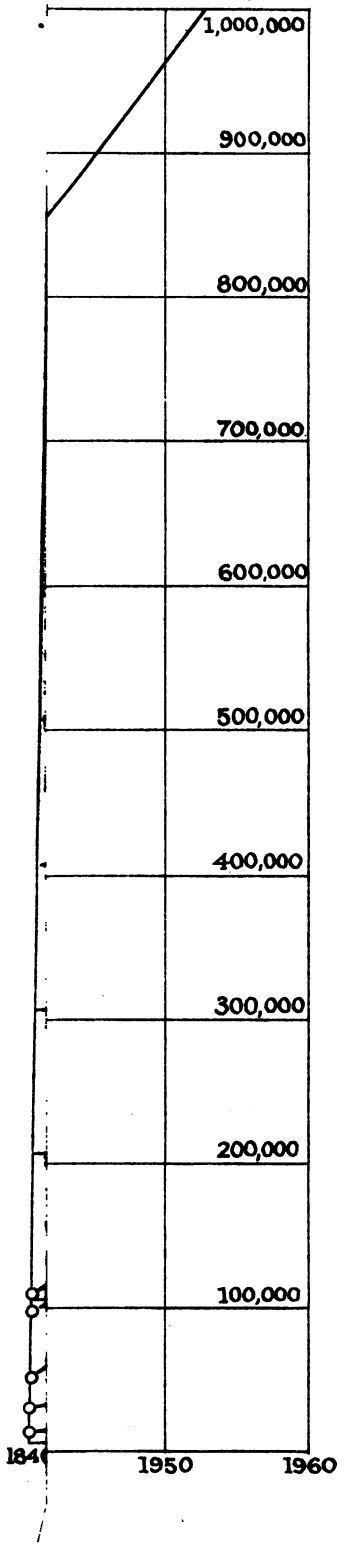
POPULATION.

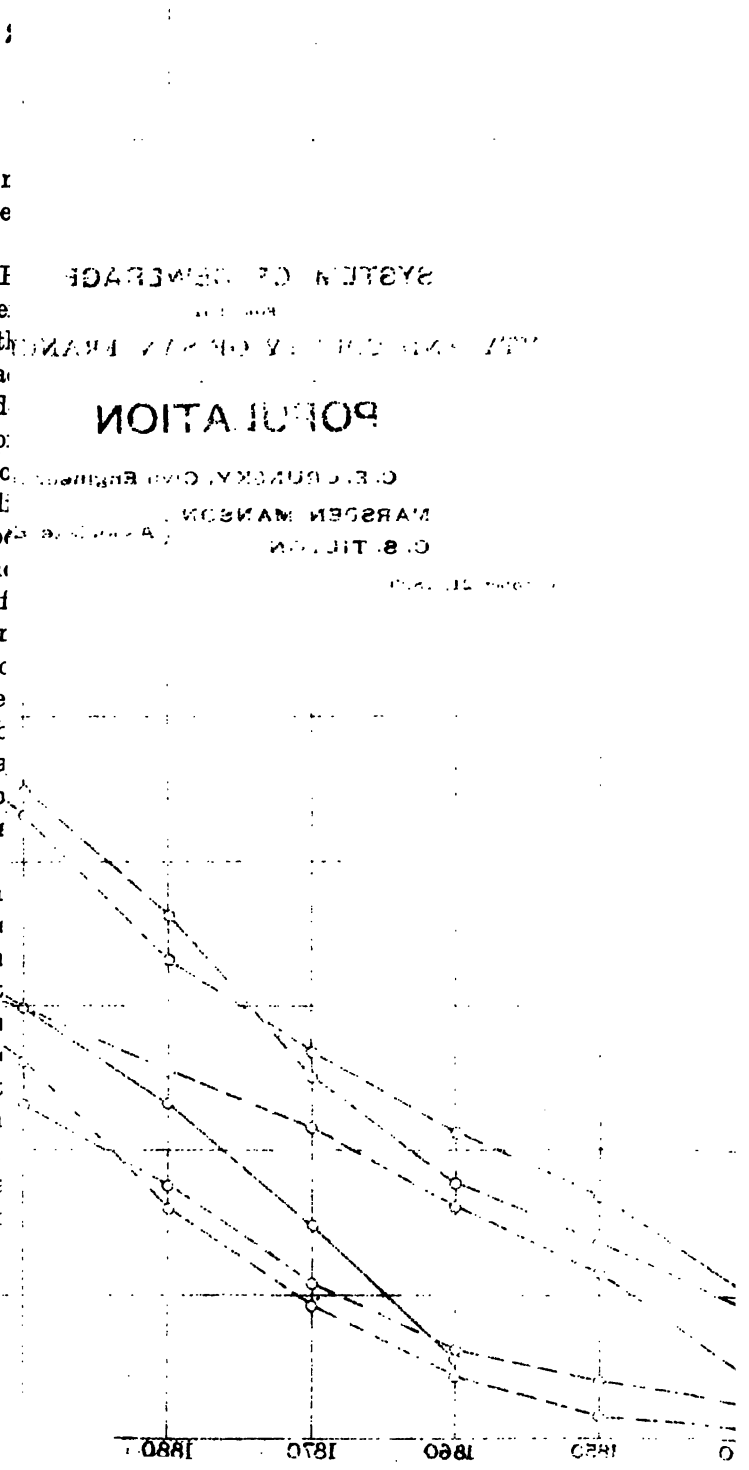
To estimate the flow of sewage proper, it was necessary to make a study of the present and probable future population of each of the several districts.

The City is divided into small precincts for election purposes. Each of these contains in the neighborhood of 200 voters, the exact number in each being disclosed by the Great Register. On the assumption of 1 voter to each 4½ inhabitants and the known acreage of each precinct, a sheet was prepared showing present density of population. This was used as a guide in estimating probable future population, but in many cases the knowledge of local conditions lead to a material departure from the results indicated by this preliminary study of the distributions of the population. Thus, it was at once apparent that in the lodging-house districts south of Market street there would be a crowding of voters into very small areas, who were not heads of families, and that it would be manifestly wrong to assign a density of population to these areas based on the same interpretation of the registration as in other districts where these conditions do not obtain. In the district inhabited by the Chinese, on the other hand, the population is more dense than the number of recorded voters would indicate, because the Chinese belong to a non-voting class.

In estimating probable future population, a reasonable allowance was not only made for the prospective extension of building areas, but the use to which these areas would most likely be put was taken into consideration. It is not necessary to follow this study in detail, but it may suffice to say that the population estimated for the different districts aggregate a little over 1,000,000, and that a study of the probable growth of San Francisco indicates that this population is not likely to be exceeded before 1955. This fact has been graphically illustrated on Plate No. 5, on which are shown the population of five other cities besides San Francisco, which, together, tend to show the rate of growth of American cities of about the size of this City.

Plate Nº 5.


1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
1840
1950
1960



CITY.	1840	1850.	186 0.	1870.	1880.	1890.
Washington, D. C.	23,364	40,001	61,122	109,199	177,624	230,392
Cleveland.....	6,071	17,034	43,417	92,829	160,146	261,383
Cincinnati.....	46,338	115,435	161,044	216,239	255,139	296,908
San Francisco...	.....	.....	56,802	149,473	233,950	298,997
Baltimore.....	102,313	169,054	212,418	267,354	332,313	434,439
Boston.....	93,383	136,881	177,840	250,526	362,839	448,477

Using the data contained in this table as a basis, the diagram already referred to was prepared and a curve was drawn representing San Francisco's probable future growth. It is proper, however, to say that this curve indicates a future population somewhat in excess of that which a careful student would predict, and that this is intentional; it being desirable, for the study now being made, to know what population is not likely to be exceeded.

According to this study, the maximum population forecast for this City is as follows:

In 1900—Population..... 380,000
In 1910—Population..... 480,000
In 1920—Population..... 590,000
In 1930—Population..... 700,000
In 1940—Population..... 830,000
In 1950—Population..... 960,000
In 1960—Population.....1,100,000

WATER SUPPLY AND SEWAGE PROPER.

The volume of sewage proper is small when compared with storm-water run-off; consequently the correct determination of its volume is of but little importance when the size of sewers to which storm waters are to be admitted is to be calculated, but it is of prime importance in those districts which are to be served by sewers for sewage only.

The per capita consumption of water in San Francisco (exclusive of the salt water pumped from the Ocean or Bay for the

supply of bathing tanks, for street sprinkling or for use in condensers) is about seventy (70) gallons. The maximum daily consumption is about eighty-two (82) gallons. These values indicate an excess of the maximum over the daily average that may in round figures be noted at 20 per cent.

It is believed that the local conditions of climate, notably our cool summers, the compact development of down-town and residence districts, and natural limitations upon the available sources of water supply, will always be such as to favor, if not compel, economical use of water in this City. According to Mr. Hermann F. A. Schussler, Chief Engineer and Manager of the Spring Valley Water Works, which company now supplies about 23,000,000 gallons of water per day to about 340,000 of the inhabitants of this City, the experience of Eastern cities, showing a gradual increase in the per capita consumption, is confirmed by local records. But when, some years ago, this consumption had reached 68 gallons, it was quickly pushed down to 55 by the liberal introduction of meters. There has been no particular endeavor made in recent years to restrict waste, because new sources of supply have been developed faster than the consumption increased; consequently the per capita consumption is now larger than it used to be. It is not likely, therefore, that the average consumption per day per inhabitant will ever greatly exceed that of the present time, or, say, 75 gallons. Allowing 20 per cent. as the excess of the maximum daily consumption over the average daily consumption, and making a small allowance for salt water pumped for bathing, street-sprinkling and other purposes (say 4 per cent.), the maximum to be taken into consideration in estimating the volume of sewage proper which will reach the sewers will be 94 gallons per inhabitant per day.

Only about 75 per cent. of this water, however, will reach the sewers. The rate at which it is to be carried off as sewage will not be uniform. The flow will be particularly light in the hours after midnight. Its maximum, late in the forenoon, will exceed the average by about 50 per cent.

Based on these facts, it is estimated that each 1,000 inhabitants might be assumed to furnish the average amount of 0.109 second-feet of sewage proper on days of maximum water con-

sumption, and that the maximum rate of flow in the sewers would be 0.163 second-feet per thousand inhabitants tributary thereto.

SOIL WATER.

Throughout many portions of the City the sewers receive an increment of their flow from the soil. Experience shows that, no matter how carefully they may be constructed, conduits of brick or iron-stone pipe for storm-waters, or for sewage only, when laid at or below the plane of soil-water, will not be entirely impervious. The amount of water which will thus drain from the surrounding soil into the sewers must be included in the volume of flow for which provision is to be made. In the light of experience in other cities, where many careful observations have been recorded, and our knowledge of local conditions, an estimate of the volume of soil-water reaching the sewers has been made and included in determining their required capacities.

The estimated amount of soil-water reaching the sewers per acre ranges from 0.001 second-feet per acre in fairly high portions of the City, with moderately heavy soil, to 0.003 second-feet in those low parts of the City where the sewers will lie well below the soil-water plane, except that in the high, sandy districts no allowance for soil-drainage has been made.

REQUIRED CAPACITY OF SEWERS AND STORM-WATER CONDUITS.

All sewers of the combined system, below storm-water relief outlets, are to have an estimated capacity at least sufficient to carry:

First—The sewage proper from the tributary district.

Second—The soil water.

Third—The run-off due to rainfall of one-quarter inch in 24 hours.

The sewers proportioned on this basis have a capacity about twice as great as would be required for sewage proper, and generally nearly four times as great as the average annual flow of sewage proper. This fact alone makes it plain that there will never be any discharge at the outfall points of storm-water reliefs except dilute sewage.

All sewers of the combined system above storm-water relief outlets have an estimated capacity sufficient to carry:

First—The sewage proper from the tributary district.

Second—The soil water.

Third—The maximum amount of storm-water run-off due to a rainfall of greatest probable intensity.

Fourth—In most cases, a small arbitrary allowance as a safety margin.

Where existing sewers are incorporated as a part of the system of mains for any district, it has in some cases been found that they fall short of the full desired capacity. In most of these cases they serve districts that are not nearly as populous now nor as fully improved as they are expected to become hereafter; so that, for a considerable period of time, neither the estimated maximum flow of storm water nor of sewage proper will be presented. There is no need of requiring the immediate reconstruction of such of these sewers as approximate the desired capacity. It will be time enough to take up the question of replacing them when it is found by actual experience that they are being overtaxed. The same remarks apply to the conduits leading from storm-water relief outlets to the water front. It is proposed to take advantage of the structures already in the ground for this purpose, notably of the Brannan-street sewer and of the Channel-street sewer. The estimated capacity of the Channel-street sewer below the relief outlet at Eighteenth street, estimated on the basis of a discharge against high tide at the head of the open water-way of Channel street at Seventh street, is less than 500 second-feet.

The ultimate capacity required to carry off the excess storm water from the Eighteenth-street outlet alone is about 650 second-feet, to which are to be added over 400 second-feet from the Fourteenth-street district, and a like amount from the Eleventh-street district. Channel-street sewer alone is inadequate to accomplish this, but its capacity will be supplemented by Brannan-street sewer, which is hereafter to serve only as a conduit for storm-water excess.

Through Brannan-street sewer, after correction of its gradient, without including the flow through emergency outlets toward Channel street at Seventh, Sixth, Fifth and other streets,

from 100 to 200 second-feet can be disposed of; but Brannan-street sewer is to receive also the excess storm-water flow from Fifth, Sixth and Seventh-street sewers, aggregating over 600 second-feet; consequently, the combined capacity of these two conduits, disregarding for the time the relief outlets to be provided in Brannan-street sewer, would ultimately be inadequate. At the present time, however, the maximum storm-water flow from the tributary area is probably less than two-thirds of the expected future maximum, and the aggregate capacity of the two conduits, when supplemented by the proposed relief outlets of the Brannan-street sewer, is sufficient to justify keeping them in service for an indefinite time without reconstruction.

The Channel-street conduit, however, should be extended with ample capacity from the present terminus of the brickwork at Ninth street to the upper end of the open water-way of Channel street.

In examining the feasibility of making this extension, it was found that Division street is obstructed by private buildings just above Seventh street. The proper route for the sewer is in a direct line to the open water-way, and this route should be made available; but, in view of the possibility of a failure to make good the City's title to this route, the longer course by way of Berry street to Seventh, thence to Channel, has been indicated on the plan, and is made the basis of the cost estimate. Portions of Channel-street sewer above Ninth street are known to be defective, but entire reconstruction should be deferred until further improvement of tributary areas and the anticipated increase of storm-water flow, due to the greater proportion of run-off, makes such reconstruction imperative.

STORM-WATER RELIEF OUTLETS.

The built-up sections of San Francisco, particularly in the older parts of the City, are excessively sewered. In adapting a project of intercepting main sewers to present conditions, the first requirement must necessarily be the delivery of sewage into the Ocean at points where it will be harmless and inoffensive. The excessive flow of storm-water run-off cannot always be carried the full distance to the outfall points selected for sewage

proper. These outfall points are necessarily remote from the centers of the districts which yield the greatest storm-water flow, and the construction of conduits of sufficient capacity for the full storm-water flow would entail great and unnecessary expense. It has already been shown that the rainfall exceeds one-quarter of an inch on only 26 days per year; consequently, that if the conduits leading to the points selected for disposal of sewage proper are planned to carry the run-off due to a rain of one-quarter inch in 24 hours, there will be about 40 rainy days on which the storm-water reliefs will not come into play, and about 26 on which there will be storm-water excess to discharge through them. Not only will a discharge through the relief outlets occur infrequently, but it will be comparatively clean water. The first run-off from street surfaces, which carries most of the street refuse into the sewers, will be carried to the main outfall points, so that the whole sewer system will have received a flushing and will be carrying comparatively clean water.

The conditions are even more favorable than indicated by these statements, which are based upon the anticipated future quantity of sewage; because, in the first place, the sewers will not be taxed to their estimated capacities until the anticipated future density of population has been reached, and, in the second place, all prescribed capacities are based upon a delivery into the Bay at extreme high tide, while actual capacity and actual discharge at all other stages of the tide will greatly exceed these prescribed amounts. In the case of the North Point main sewer, for example, the average flow will exceed the flow at high tide by about 20 per cent. As the sewer is projected of ample capacity to serve future requirements at the high tide stage of the Bay, this excess of outfall capacity will at all times, except during extreme high tides, serve to keep down the flow through the emergency reliefs.

The flow of sewage, moreover, which entered into the computations of sewer dimensions, is the maximum which exceeds the average flow on the day of greatest water consumption by 50 per cent., and which exceeds the mean annual flow by about 80 per cent.

Finally, it remains to be said that the emergency reliefs will be most likely to be in service during high tides, being the time when the outflow from the main sewers is a minimum. But this is

the time when their output into the Bay is least harmful, as there is then the greatest probability of its quick and complete removal from the outfall locality by the immediately succeeding ebb-tide.

In the districts already sewered the relief outlets will discharge into some of the mains now in service. Army-street sewer, Channel-street sewer and Brannan-street sewer will be notable examples of sewers whose services will hereafter be restricted almost entirely to the discharge of the excess storm-water run-off. The lower portion of Army-street sewer, as hereafter explained, will combine the functions of a main sewer and a storm-water relief conduit. There will be no dry weather discharge from these sewers, as at present. Their service will be restricted to storm periods, and the excess flow which they will discharge, being mainly rain water, reaching the sewers from roofs and street surfaces, will, as already explained, be sufficiently harmless and inoffensive, to be discharged temporarily at any convenient point into the Bay.

Storm-water relief outlets are all of a similar type, unless otherwise specially described. In each case the sewer is widened out, the greater span of the arch or the flat roof of the chamber covering not only the sewer, but also a second channel alongside the sewer proper. Between the sewer proper and this second channel there is to be a weir, in reality the wall of the sewer, carried vertically to the required height of the overflow. Over this weir the storm-water excess will fall into the second channel, and this will lead it into the conduit, generally an existing sewer, which will take it to the Bay.

SEWAGE DISPOSAL.

The necessity of making and keeping densely populated areas healthful has given rise to sanitary science.

One of the fundamental requirements of this science is, that excreta and domestic waste must be disposed of before putrefactive fermentation has set in—the products of such fermentation being offensive and highly dangerous.

The modern method of sending excreta and much domestic waste into conduits which are to carry them to points of disposal is by liberal dilution with water. Water thus contaminated is sewage proper.

The ultimate disposition of this now offensive liquid is a problem to each locality, but certain methods of disposal have been developed and found to be satisfactory. In brief these methods are:

First—Dilution by discharge into great bodies of water.

Second—By chemical treatment rendering the putrescible matters into harmless and utilizable forms and furnishing a partially purified effluent which can without serious danger be discharged into large streams.

Third—By rapid filtration and oxidation in filter beds, or by application to land for irrigation.

The first method of sewage disposal is always adopted when conditions permit. The second and third, being more costly, are resorted to only when the advantageous conditions permitting the use of the first are absent.

The strength and volume of tidal currents, which are available and within such easy reach in the case of this City, are so great, when compared with the volume of sewage, that it is manifest that only the first method of disposal need be considered.

[Note.—By some mistaken economists, the discharge of sewage into large volumes of water is considered a waste of fertilizing materials. But the cost of extracting these by chemical methods or of utilizing them for irrigation is often greater under unfavorable conditions than the cost of producing equivalent effects by other methods.]

OUTFALLS FOR THE SEWAGE OF SAN FRANCISCO.

The peninsula upon which San Francisco is being built is washed on three sides by tidal waters.

On the west it faces the Pacific Ocean. The greater portion of this frontage is a flat, sandy beach extending southerly from Point Lobos. Northerly from this point to Fort Point the shore is precipitous, with a few sheltered nooks between projecting rocky points.

The northerly frontage from Fort Point to North Point is on the entrance to the Bay. Over a portion of this frontage a seawall has been built, and, when projected and partly executed works shall have been completed, this front will present quite a direct and regular alignment.

The east, or Bay, frontage has been improved along the northerly end from North Point to Rincon Point. The portion from this point to Potrero Point has been partially built upon, following an alignment adopted in 1852, but which has since been changed to a more easterly position not yet occupied by structures. The remainder to the County line is practically unimproved.

The most pronounced point projecting into the Bay on this frontage is Hunter's Point (or Point Avisadero). On both sides of this point there are extensive tidal flats which have been sold by the State, with the exception of certain small reservations known as basins, which can be enlarged or increased in number and dredged as commercial needs demand.

North of Hunter's Point Potrero Point projects much less prominently, and further south minor points exist, but they do not reach deep water.

The original Bay shore alignment is deeply broken by Mission and Islais Creeks; these were short, shallow tidal estuaries which received the drainage from adjacent uplands.

Mission Creek has given place to Channel street, a narrow dead-end channel which projects westerly into the City for about a mile, and now receives a greater portion of the sewage of the City, and is an increasing source of disease.

Islais Creek enters the Bay between Hunter's and Potrero Points. A channel has been reserved in the adjacent tidal flat projecting about a mile westerly. Across this channel Kentucky street has been carried on a fill, which is pierced by a culvert through which the tide ebbs and flows to above San Bruno road about one and three-quarter miles to the west of Kentucky street.

These shore line conditions have afforded ready, though objectionable and offensive, outfalls for sewers at any point on the three sides of the peninsula or into shallow, dead-end tidal channels. The ill-advised utilization of these points of discharge has fouled much of the Bay shore, and particularly the low, flat areas of the estuaries.

TIDAL AREA OF SAN FRANCISCO BAY.

When the tidal marshes are covered at spring tides, San Francisco Bay has an area of 740 square miles.*

This includes the three divisions of the Bay—San Francisco Bay (proper), San Pablo and Suisun Bays, and the adjacent marsh lands. These lands aggregate three hundred (300) square miles, all of which have been sold and a small fraction reclaimed. This leaves 440 square miles of bay area. Of this bay area, where it has scant depth of water at low tide, the State has sold 105 square miles in San Francisco and San Pablo Bays. It is probable that it will not be found profitable to reclaim all of these submerged lands, since such industries as oyster growing are more profitable than these lands can be made for other purposes. Again, the development of any portion of them for commercial or industrial purposes will necessitate the reservation of an adjacent area for docks and basins, so that not so great a reduction of tidal area is to be anticipated as the above figures indicate.

The shape and extent of the tidal area inside the entrance of the Golden Gate is such that at extreme limits the difference in the times of high water is nearly 4 hours and of low water nearly 5 hours. These differences in time and the known directions of the currents justify the view that although the entire tidal area of Suisun Bay cannot be relied upon to directly influence tidal currents on the east and north frontage of the City, it is still safe to estimate the available tidal area at an ultimate minimum limit of between 300 and 350 square miles. A reduction to such area is, however, not likely to take place within any period now foreseen and provided for; neither is it possible to forecast, except within very wide limits, the rate and extent to which reductions may be made; nor is it certain that if accomplished they will greatly reduce tidal currents and velocities at the selected points of outfall.

RANGE OF TIDES.

The tidal fluctuations of the Bay are thus referred to by Professor George Davidson in the "Pacific Coast Pilot":

"From the lower low water ('low water large') the tide rises

(* See Report of Col. G. H. Mendell, Corps of Engineers, U. S. A. Tidal Area of San Francisco Bay. Ex. Doc. No. 93, 46th Congress, 3d Session, p. 3.)

for about 7¼ hours, say 4.4 feet, to the smaller of the two high tides ('high water small'); then falls 1.4 feet in less than 4½ hours to the 'low water small,' which is higher than the preceding low water; then rises, say 2.9 feet in 6¼ hours to the higher high water or 'high water large'; it then falls again 5.8 feet in over 7 hours to the lower low water, or 'low water large.'

"Instead of the above figures, the fall from high water small, or 'half tide,' to the 'low water small,' may range from 3½ feet at one position of the moon to 0.3 foot at another; in the latter case there will be apparently a long stand of about 5 hours. * * *

"The average difference of the higher high and lower low waters of the same day is 5.2 feet, with a greatest observed range noted for February 8, 1876, of 9.93 feet."

It may be noted in this connection that the predictions as published in the Tide Tables for 1899 by the United States Coast and Geodetic Survey show:

Expected mean range of tides, 4.5 feet.
Expected mean range of spring tides, 5.4 feet.
Expected mean range of neap tides, 3.5 feet.
Expected mean range of great tropic tides, 7.2 feet.
Expected maximum range in 24 hours of 7.8 feet.
Expected minimum range in 24 hours of 3.1 feet.

These tidal ranges, when applied to the area of the Bay and adjacent submersible lands, with due consideration of the difference in time at which the tides occur in different parts of the Bay, determine the volume of flow in and out of the Golden Gate. It is but to be remembered that the ebb exceeds the flood by reason of the inflow from tributary rivers.

This contribution of the rivers is not inconsiderable. Sacramento and San Joaquin rivers contribute in excess of 4,000 second-feet at their lowest autumn stage, and over 80,000 second-feet throughout the first six months of the year, often reaching from 150,000 to over 200,000 second-feet for short periods of time.

The drainage areas of these rivers aggregate over 58,000 square miles, and there are in addition about 4,000 square miles directly tributary to the Bay (including Bay area).

TIDAL CURRENTS.

The tidal currents resulting from the ebb and flow of the tides, augmented by the river discharges, are the agents for securing a thorough dilution and removal of the sewage. In the case of San Francisco, the only precaution to take in accomplishing this is to discharge the sewage in strong currents, and not in sluggish, eddying waters.

The great dilution to be expected when so treated will be apparent when it is considered that the total water consumption of the City for domestic and other ordinary uses, will be only 75,000,000 gallons per day, or 116 second-feet when the population of the City reaches the million mark, and this may be taken to represent approximately the amount of sewage that will in the aggregate then be discharged into the Bay and Ocean waters.

In order to determine the points at which to deliver sewage so as to give a maximum dilution with sea water and the most direct discharge into rapid tidal currents, the Sewage Commission of 1892-93, and subsequently the Engineers in Charge to Devise and Provide a System of Sewerage, had a series of current observations made. The result of these observations have not before been discussed. Tidal current observations were made by the U. S. Coast and Geodetic Survey in 1872-75, and have aided materially in confirming conclusions as to the best points for sewage disposal.

The principal points which were selected for float observations in 1893 were Hunter's Point, Potrero Point, Center-street Pier and Powell-street Pier. Floats were set free from these points at all stages of the tide, and their course observed and platted. The results of these observations may be summarized as follows:

Floats from Hunter's Point.—At flood tide all floats passed up the Bay clear of tide marsh and shore line. At ebb tide all cleared Potrero Point over half a mile and passed east of Mission Rock.

Floats from Potrero Point.—(Sugar Refinery Wharf.) At flood tides all floats trend inside of the line between Potrero and Hunter's Points; one passed into eddy south of Potrero Point. At ebb tides all floats trend easterly off Mission Rock and into

deep water. One was caught by incoming flood and turned southeast off shore into deep water.

Floats from Potrero Point.—(Rolling Mill Wharf.) At flood tides all floats hugged close in shore towards Hunter's Point. At ebb tide all passed close to Center-street Pier and west of Mission Rock.

Floats from Oil Wharf.—(Center street.) At flood tides all floats moved close to Potrero Point. At ebb tide one float moved northeast into the channel east of Mission Rock. The other passed west of Mission Rock.

Floats from Powell-Street Pier.—At flood tides three of the floats moved east into deep water; the other three moved along Pier Head line for one-half mile, and showed a tendency to gradually approach shore, and were towed out from Pier Head line several times. At this point more than at any other the course of the floats made it apparent that the flood flow is dispersive, causing waters from the center of the Bay to move shoreward, and the ebb flow concentrative, drawing the water into channel lines. At ebb tide all cleared Black Point, most of them over one-quarter of a mile.

A further study of these observations and of the current charts above referred to show:

First—That tidal and littoral currents of moderate velocity prevail between Fort Point and Point Lobos.

Second—That tidal currents of from 0.9 to 3.3 feet per second prevail along the north front of the City. That these currents, particularly at ebb tide, do not recurve into the shore to any extent that would interfere with thorough dilution and dispersion of discharged sewage, if the discharge be effected some distance off shore.

Third—That currents of from 0.6 to 3.8 feet per second prevail along the east front of the City, and that at certain points they do not recurve shorewards.

For convenience it is stated that a current of

1 foot per second equals 0.68 miles per hour.
2 feet per second equals 1.36 miles per hour.
3 feet per second equals 2.04 miles per hour.
4 feet per second equals 2.72 miles per hour.

THE SELECTED POINTS OF DISPOSAL.

These factors, with due regard to the shore topography and meteorological conditions, lead to the conclusion that no discharge of sewage should ever be permitted on or across the beach south of Point Lobos, and that only storm-water drainage should reach the Ocean on the western front of the City. The beach will for all time be a pleasure and health resort, much of it a public park of great attractiveness and use, and the prevailing westerly winds of that locality should be kept pure and fresh to ensure health, and no step should be taken which would in time result in rendering the beach offensive or dangerous in the slightest degree.

It was also made apparent that at almost any point of the northern frontage of the City, from Point Lobos eastward to North Point, but particularly at either of the three prominent points, Lobos, Fort and North Points, sewage could be safely discharged with the sole precaution of letting it go well off shore and in deep water.

The view that the eastern frontage of the City, from near Market street southward to Islais Creek, is not a desirable locality for disposing of sewage was confirmed; but it was found that Hunter's Point offered exceptional advantages as a point for a delivery into swift tidal currents with ample and thorough dilution.

It remains to be stated in this connection, however, that the discharge of sewage in limited quantity through submerged pipes in deep tidal waters is rarely objectionable, and that therefore small shore areas which cannot be made tributary to the contemplated main sewers except by pumping, may, with proper restrictions, be permitted to discharge into the Bay at other points than those named. Such shore areas should either deliver their sewage into the intercepters which are to be now provided, or should send their sewage far off shore.

In accordance with these conclusions and the existing conditions, the following points of disposal have been selected:

First—Off North Point, in at least six fathoms of water at low tide, and 1,200 or more feet from the water front line.

Second—Off Hunter's Point, in a corresponding depth.

Third—Off the Ocean shore, at the west end of Twenty-seventh avenue.

Fourth—Off the foot of Scott street, in at least six fathoms of water at low tide.

Two other points are to be taken into consideration, Fort Point and Point Lobos. The latter will become a point of discharge when the tunnel is carried northward from the West Richmond pumping station. The former in the indefinite future, if the North Point main be ever extended. These two points would then take the place of all others on the northern frontage of the City.

The areas now tributary to these points of outfall, or to be ultimately tributary thereto, will best be understood by a study of the accompanying plans. The North Point main is to receive the sewage from 11,500 acres, including the present residence and business portion of the City, to the extent of about 80 per cent. of existing population, and is to be at once constructed. It will serve for an indefinite period in the future, and will be merely extended when the discharge of sewage at Fort Point shall become desirable.

The Hunter's Point main is to receive the sewage from 2,300 acres lying upon the slopes of Hunter's Point peninsula, and southwest therefrom. For the present, a temporary outfall is to be provided, to be used until the tributary area shall be more densely populated, and the streets on the north side of the peninsula shall have been graded.

The Point Lobos outfall will ultimately receive the sewage from the greater portion of the Ocean slope of this City and County. Until the population of the tributary areas shall become sufficiently dense to justify its construction, the existing outfall at the westerly terminus of Twenty-seventh avenue is to be extended and utilized.

The Scott-street outfall is to serve for the Harbor View District until it becomes desirable to extend the North Point main to Fort Point.

At all of these points the disposal is to be well off shore, and all are swept by tidal currents which will rapidly and effectively dilute and remove sewage. It is not probable that the population of the tributary areas will be dense enough at any time now fore-

seen to cause adjacent areas of water or shore to be noticeably fouled.

It will be seen from the above that there are ultimately to be three points of outfall, Point Lobos, Fort Point and Hunter's Point, but the requirement to effect a delivery at Fort Point is, as elsewhere stated, altogether too remote to need consideration at this time.

Until the necessity shall arise for a delivery at Fort Point, North Point and off Scott street are to be used, and until the population on the western slope of the peninsula shall justify the construction of the Point Lobos outfall, the extension of the Twenty-seventh avenue outfall is to be utilized.

It is not possible, with the data now available, and in the limited time available, to attempt to express in figures the degree of dilution to which sewage delivered at the selected points will be subjected. In each instance, however, the conditions of dilution and removal are more favorable than those at Baltimore, Washington or Boston. The outfall at Baltimore was selected by Messrs. Mendes Cohen, F. H. Hambleton and E. L. Bartlett, the Sewerage Commissioners for that city, and the discharge is into Chesapeake bay. In the case of Washington, the discharge is into the head of the estuary of the Potomac, as selected by the Board of Sanitary Engineers, Rudolph Hering, Samuel M. Gray and Frederic P. Stearns, and, in the case of Boston, into Boston harbor, as carried out under the recommendation of the Commissioners of 1875, consisting of E. S. Chesborough, C. E.; Moses Lane, C. E., and C. E. Folsom, M. D., under the advice of the principal Assistant Engineer, Eliot C. Clarke, and as now under contemplation for the high intercepting sewer as projected for the Metropolitan Sewerage Commission within a year by their Chief Engineer, Mr. Wm. M. Brown, Jr.

We therefore feel confident that in delivering the sewage of San Francisco at the points selected no offense nor danger will result.

SEWER FLUSHING.

The custom of attempting to flush the defective sewers of San Francisco in the late summer and early autumn months has given rise to the idea that all sewers need flushing. It is made

very apparent through the sense of smell that they need something, and it is at once concluded that flushing is the remedy. But the examination conducted in 1892-93 by the Board of Engineers shows plainly that the defects in the sewers are such that flushing cannot accomplish its purpose, and that when these defects shall have been corrected the nuisances which appear to call for flushing will hardly occur, and properly applied flushing devices and the ordinary application of flushing by water may then be made efficient when necessary.

It should be well understood that in a well-designed and well-constructed sewer system, the mains and sub-mains should remain clean or may be entirely cleansed by flushing devices utilizing the sewage itself for this purpose.

The entire lack of system which characterizes the existing sewers of this City has given a very exaggerated importance to the idea of flushing sewers with salt water. The stenches from our sewers in August and September of each year are caused, not altogether by a need of flushing, but by irregularities and defects in grades and sizes which permit accumulations of sewage, which gradually putrefy. Hence, after the full volume of water from a three or four-inch hose has been poured under pressure into the storm-water inlets, for hours the stench remains. No reasonable volume of water will flush a sewer having the defects of construction explained in the Reports of 1892-93.

Only the systematic correction of grades and the proportioning of sizes to the volume to be carried, will prevent these accumulations of putrescible matter.

There are many individual instances and types of very defective constructions throughout the City which could be cited that will not in any manner be improved by flushing. But when these defects shall have been corrected, and the new mains herein provided for shall have been constructed and equipped so far as necessary with flushing arrangements, the needs and costs of additional flushing will be greatly reduced, and in the main restricted to dead-ends.

It is therefore recommended that the subject of flushing the lateral sewers be left for future consideration of the Board of Public Works, when the systematic correction of known defects

shall have been accomplished and the necessity for, cost and extent of its application greatly reduced.

THE SEWERAGE DISTRICTS OF SAN FRANCISCO.*

The existing sewerage of San Francisco, and its lack of system, was described in the Report of the Engineers in Charge to Devise a Sewer System, in which two of the Engineers connected with the present work participated. The report then made was to have been supplemented with a detailed description of sewers then in service, which might be dignified with the name of mains, but the summary termination of the work left no alternative except to refer to the maps and records which had been prepared for specific information relating to these as well as to the great network of connecting sewers.

The plan for providing sewers as followed in the past seems to have been to construct egg-shaped sewers 5 feet high by 3 feet wide along all streets and alleys where property was valuable and could afford to pay for large sewers. These were made to intersect at nearly all street crossings. The absurdity of providing conduits of so great a capacity where a small pipe would answer seems to have been realized after a time, and pipes came into use, but they also were used without system. The plan of constructing intersecting sewers at every street crossing was adhered to until quite recently. This method of arranging the conduits makes district boundaries indefinite. Large areas may be tributary to any one of several main sewers, and the study of the output or flow of sewage from any district is made well nigh impossible. Such study would at least require an amount of preparation involving the building of temporary bulkheads in so many sewers that a study of this kind for any district of large area has been entirely out of the question in the time and with the means available for the present inquiry and report.

As the built-up area of the City extended, sewers were in most cases speedily provided, though it often took years to secure their extension to outfall points at the water front.

It is hardly necessary to say that, without exception, all sewers heretofore constructed were to serve on the Combined System,

* See Appendix C.

receiving both sewage proper and the storm-water run-off. Main sewers were carried along valley lines where these were of a pronounced character, as in the case of Army street, Eighteenth street, Fourteenth street and Eleventh street; while, in other cases, as in the flat Yerba Buena District, every street and alley in both directions is provided with a sewer sufficiently large to be called a main.

The description in detail of existing sewers will be omitted at this time, except to the extent that may be necessary in order to make the present project for main sewers intelligible.

Having reached the conclusion that the best points for sewage disposal are those points of the water front which are swept by swift tidal currents, with a preference for those nearest the Golden Gate, it was determined that the best point of outfall now accessible was off-shore from North Point, and that a limited amount of sewage could be discharged at Hunter's Point without harm and without offense; and that, if necessary, other points of outfall between North Point and Point Lobos could be established, it being only necessary to effect discharge from submerged pipes in deep water far off shore.

The study which was thereafter made of the feasibility of constructing intercepting sewers leading to North Point and to Hunter's Point confirm their advantages as points of disposal.

In general, the dividing ridges between the various watersheds and their subdivisions constitute the division lines of districts and sub-districts. The valley lines of these districts fix in a general way the position of the mains or sub-mains. But in delivering the sewage to the selected points of outfall it has sometimes been found economical and advisable to pierce the ridges by tunnels. Tunneling is also found to be in some cases cheaper than to tear up a costly pavement, shift or brace up street-car tracks and gas and water mains. The cases in which this has been resorted to will appear in their proper order.

LIST OF DISTRICTS.

Name of District and of Sub-district.	Area Acres.	Estimated future population to be served.
North Point—		
County Line West	836	24,800
County Line East	381	8,500
Persia Avenue	246	7,300
Sunny Side	579	21,700
Glen Park	582	17,500
Silver Avenue West	177	5,300
Valley street and Upper Army street	794	31,700
West Bernal Heights	149	6,000
Lower Islais Creek	1,125	47,900
West Potrero, Upper Twenty-second	620	31,000
Eighteenth Street	660	33,000
Fourteenth Street	1,307	74,500
Miscellaneous	27	1,600
Eleventh Street	978	54,400
East Potrero	334	16,700
Fifth Street, including Sixth Street, Seventh Street and miscellaneuos	782	103,700
Kearny Street	41	6,200
Mission Flats	845	72,500
North Rincon Hill	126	15,700
Portsmouth	157	31,000
Yerba Buena	279	33,500
North Beach	500	30,000
Totals	11,525	674,500
Hunter's Point—		
College Homestead	122	3,700
Gaven Street	68	2,000
St. Mary's	91	3,600
South Bernal Heights	123	4,900
University Mound	488	14,600

Name of District and of Sub-district	Area Acres.	Estimated Future Population to be Served.
West Silver Terrace and Miscel.....	65	2,000
North Silver Heights.....	77	3,100
Railroad Avenue.....	115	4,600
North Slope Hunter's Point.....	306	12,200
Bay View.....	590	23,600
South Slope Hunter's Point.....	249	10,000
Totals	2,294	86,300
Harbor View	816	48,100
Richmond	1,200	60,000
West Richmond	212	19,200
Upper Sunset	1,658	64,200
Lower Sunset	2,564	98,600
Ocean View	783	29,800

The areas here noted, owing to necessary indefiniteness of district boundaries, are to be considered tentative only, and must remain subject to slight corrections, as tracts not now graded nor even subdivided shall be improved. They have served as a basis for estimating required sewer capacities of the several districts.

THE NORTH POINT DISTRICT.

Area, 11,525 acres.

Estimated future population to be served, 674,500.

The North Point District embraces about 11,525 acres, or 18 square miles. Within this area now live about 80 per cent. of the population of the City. Its boundary may be described in general terms as follows: Commencing at the north frontage of the City at Black Point, thence along the summit of the Russian Hill ridge to Jones and Pacific streets; thence westerly along the divide between the Bay drainage and the Ocean drainage to the County Line; thence easterly along the County Line to the divide between Islais Creek and Visitacion Valley; thence along this divide to a point thereon southeast from the intersection of

Mission street and Springdale street; thence to Holly Park, and down the southerly slope of Bernal Heights to the base of the hills on the south side of Islais Creek and along this base to Kentucky street; thence along this street and the Bay frontage to the point of beginning.

The alignment of the North Point main which serves this district is shown on the accompanying plan, Sheet No. 4. It is projected to carry and discharge the sewage it receives by gravity. It is designed to carry the sewage proper of this district when the population of the City reaches 1,000,000, together with the run-off of one-quarter inch rainfall in 24 hours. It has already been noted, in the rainfall discussion, that this amount of rain per 24 hours is exceeded on only 26 days per year on the average. When, during heavy rainfall, a larger volume of run-off reaches this sewer the excess is provided for by relief outlets leading directly to tide water.

The subdistricts of the North Point District are as follows: *

By Gravity—

North Beach, with sewers on the Combined System.
Portsmouth, with sewers on the Combined System.
North Rincon Hill, with sewers on the Combined System.
Kearny Street, with sewers on the Combined System.
Fifth Street, including Sixth and Seventh and miscellaneous, with sewers on the Combined System.
East Potrero, with sewers on the Combined System.
Eleventh Street, with sewers on the Combined System.
Fourteenth Street, with sewers on the Combined System.
West Potrero, with sewers on the Combined System.
Twenty-second Street, with sewers on the Combined System.
Upper Army Street, with sewers on the Combined System.
West Bernal Heights, with sewers on the Combined System.
Valley Street, with sewers on the Combined System.

Upper Islais Creek, embracing the following:

Glen Park, with sewers on the Combined System.
Sunny Side, with sewers on the Combined System.
County Line West, with sewers on the Combined System.

(* See Plates Nos. 6 and 7.)

County Line East, with sewers on the Combined System.
Persia Avenue, with sewers on the Combined System.
Silver Avenue West, with sewers on the Combined System.

By Pumping—

Yerba Buena, with sewers on the Separate System.
Mission Flats, with sewers on the Separate System.

Lower Islais Creek, embracing the following:

Lower Army Street, with sewers on the Combined System.
East Cortland Avenue, with sewers on the Combined System.
Islais Creek Flats, with sewers on the Separate System.
South Potrero, with sewers on the Separate System.

North Point was found to be about as far west on the northern frontage of the City as an intercepting sewer could be made to discharge successfully by gravity flow. Should it ever be found desirable to extend the North Point main, then, near its outlet, a pumping station will have to be provided to lift the entire volume of sewage sufficiently to permit of an extension of the sewer westerly along the water-front.

Such an extension as indicated in the report of 1893 may in time reach Fort Point, but this extension is not now needed and cannot be made until the northern water-front shall have a continuous line of improvements. Its discussion at this time is premature except that it is important to note its feasibility. By selecting North Point as the termination of the main intercepting sewer, it was found that all existing sewers to the west of Montgomery street, all above Howard street to Eighth, the Eleventh and Fourteenth-street sewers above Harrison street, and the Eighteenth-street sewer, as well as Upper Army-street sewer and almost the entire drainage from Potrero Hills could be made directly tributary to the main by gravity flow. It was also found that the whole area of Islais Creek above the crossing of Mission Road extending beyond the County boundary, and including several hundred acres of San Mateo County, could be made tributary, also by gravity flow, to the same sewer by tunnel about 4,500 feet long. The northern slope of Rincon Hill, too, and other small areas east and south of the selected route are also by reason of their elevation to be served by this sewer by gravity,

while the low lying districts east of Montgomery street and south of Howard will also be dependent upon it as a main, becoming tributaries to it through pumping systems which will give these districts perfect service independent of tides.

The gradient of the North Point main is controlled by the elevation of the street surface along its route.* It was found necessary to place it low enough to serve the district in the vicinity of Fourteenth and Harrison streets. It is a well-known fact that in that locality many street grades have been established without due regard to future requirements and to the injury of adjacent property. The established grades, however, are the grades to which the project has been fitted, it having been the aim to keep the hydraulic grade line—that is, the water surface elevation at its highest stages—as far beneath the street surface as possible.

To illustrate the advantages which would result from a revision of grades, it may be noted that at Eighteenth and Division streets the officially established grade is 7.5 feet above City Base, while all around this point grades range from 10.5 to 13 feet. Here is a pot-hole arrangement that every adjacent property owner should protest against. Let the storm-water inlet become choked and there will be a speedy accumulation of drainage, even when sewers are not surcharged, that will inundate the street surface and private property to a depth of three feet before there can be any relief. Inundations from such causes have frequently occurred in the past history of the City. At Thirteenth and Harrison and at Fourteenth and Harrison streets there is a similar saucer-shaped depression; grades 6 and 6.5 feet are entirely surrounded by grades several feet higher. Similar conditions exist at the northern termination of York, Florida and Alabama streets; also at the intersection of Fifteenth and Shotwell streets; at Sixteenth and Shotwell streets; at the eastern termination of Fifteenth street; on Folsom, midway between Sixteenth and Seventeenth streets, and at Fourteenth street, and still the list is not complete, because, if remodeled, it would be found that still other grades should be raised to completely eliminate the pot-hole feature.

The surface drainage in such cases must either succeed in finding its way downward into the sewers or it will surely accu-

(* See Plate No. 8.)

mulate in the streets and flow out upon private property. It should be distinctly understood by the owners of property adjacent to such low spots as here referred to that their cellars cannot be satisfactorily drained by the sewers which carry storm-waters, neither as now in service nor as they will be after improvement. When this fact is fully realized by the property owners, and that they will always be in much greater danger from inundation than if grades were raised, they should, and, it may be hoped, will, ultimately unite in requesting a revision of grades to afford relief. Water has, during severe storms, year after year inundated this district. The proposed increased capacities of sewers and storm-water drains will greatly ameliorate this condition; but the mischief done by the establishment of faulty street grades cannot be entirely undone by construction of sewers, and it must be left to the property owners to find out how much more valuable their property would be if the high-water line in the sewers could be kept 5 or 6 feet below the street surface instead of rising almost to it. The only satisfactory remedy lies in raising grades, and particularly those grades already enumerated which make pot-holes of the street surface. Present property owners are probably innocent sufferers from the desire of their predecessors to have official grades established at natural ground height to save the cost of grading to higher lines. The lack of proper outfall for the storm-waters has been frequently blamed for inundation of basements and of streets near Fourteenth and Harrison streets, but these floods are not chargeable to defective sewerage alone. Repeated efforts, however, have been made to prevent recurrence of such inundation by changing sizes and alignments of sewers. That there have been no floods for several years in that vicinity is not due to such improvements alone, but also to the fact that we have had a succession of winters of less than ordinary rainfall.

The amount of run-off in the districts tributary to sewers above Fourteenth and Harrison streets is increasing from year to year as the area of impervious surface, street improvement, as well as sidewalks and roofs, increases. The study of required capacity for storm waters and sewage is, therefore, timely, and the added capacity of the new outfall main will be of great advantage in the matter of preventing an outflow of storm waters

upon the street surface. But under the improved conditions the extreme high-water line will, as already stated, still lie undesirably near the street surface, and a large area of property would be greatly and permanently benefited by a revision of the grades.

The North Point main will intercept the sewage and one-quarter inch of rainfall per day of Army-street sewer at Valencia street, thus serving the upper portion of Precita Valley, and will also serve upper Islais Creek in a similar way. Sufficient capacity will be given the main sewer which will leave Islais Creek Valley in a tunnel and which will follow the alignment of Mission Road northeastward from its crossing of Islais Creek, to carry the sewage from the Upper Islais Creek District, including the run-off due to a rainfall of one-quarter inch in 24 hours. All excess storm waters will be discharged into a conduit hereafter to be provided, following the Islais Creek Valley line. Until the property along the Creek is improved, the open water-way of the Creek must continue to serve for this excess in its present condition as a flood channel. The excess storm-water flow of Army-street sewer will, in the same way, be discharged at Valencia street into the lower section of this sewer, and will flow to a suitable outfall point at the Islais Creek Channel.

Twenty-second Street and Valley Street Districts will both be directly tributary to the North Point main below or south of Army-street sewer, also the west slope of Bernal Heights and the western, northern, almost all of the eastern and a part of the southern slope of the Potrero Hills.

In the entire region served by this main by gravity flow the system of collection is to be that now in use—the Combined System. The sewers already constructed are to remain in service, but it will be necessary to supplement them and occasionally to reconstruct some which are now defective and which are intended to serve as main sewers; also to alter many interconnections so that definiteness may be given to the area served by each. Also to correct certain irregularities in grades and sizes so as to prevent the accumulations of sewage deposits which now cause nuisances.

The districts on the eastern Bay frontage not tributary by gravity flow to the North Point main sewer are as follows:

(1). Yerba Buena, in which it is proposed to establish a sep-

arate system of sewers for the collection of sewage only, which will be delivered into the North Point main by pumping.

(2). Mission Flats, extending from Howard street to the northern base of the Potrero Hills and from the Bay inland as far as Fourteenth and Harrison streets, which is to be served in a similar way by a separate system of sewers, those now in use remaining in service as storm conduits. The sewage proper of this district will reach the North Point main near Fifth street.

(3). Lower Islais Creek, including the greater portion of the southern slope of Potrero Hills, that portion of Precita Valley directly tributary to lower Army-street sewer, and the lower portions of the main Islais Creek Valley as far up stream as to point about 3,400 feet above San Bruno Road.

The eastern limits of the Islais Creek District must for the present remain somewhat indefinite because, according to the order in which and purposes for which lands to the eastward of Kentucky street are improved, more or less of these lands now under the water of the Bay can be included. A part of this district notably the slopes on both sides of Precita Valley, the lower slope of Bernal Heights (which has been named for convenience East Cortland Avenue District) and a part of the southern slope of Potrero Hills will be served by sewers under the Combined System, while the low-lying portions, the flats proper and the eastern part of the southern slope of Potrero Hills, will be sewered under the Separate System, and the dry weather flow of sewage from high land portions of the districts, including small allowance of storm-water, are to be pumped over the low divide between lower Precita Valley and Mission Valley, and will thus also reach the North Point main sewer. The excess storm-water flow is to be discharged into Islais Creek.

YERBA BUENA DISTRICT.

This district embraces all of the low ground between Telegraph Hill on the north and Rincon Hill on the south.

The existing sewers are to be remodeled to carry storm waters, and only the principal ones, where repairs are so extensive as to amount to reconstruction, are shown on the plans; but,

as already stated, the cost of remodeling these drains is included in the cost estimate.

Centrally located in this district there is to be a pumping station, toward which the sewers for sewage only (shown on Plate No. 7) are to converge. The preferred location for this pumping station has been indicated in the plan, but this location need not be rigidly adhered to. Wherever located, the receiver is to be covered and provided with a ventilation system. The pumping station will not be offensive. The main sewers are to reach the receiver at the pumping station at considerable depth, about 15 feet, in order that laterals at some distance from the pumping station at the extreme ends of the district will be feasible at sufficient depth below street grades to serve efficiently. The sewers for sewage only are to receive no rain water, not even roof-water, except at such points of the upper ends of the laterals as may seem desirable to aid in flushing.

The mains of this district will be large pipe sewers. Where the most important mains are in bad ground they are to be supported by piling; others are to be imbedded in concrete in order to increase their stiffness and to ensure uniform settling, in case there should be any further slight subsidence of streets as noted for this district in the past.

It is not necessary to enumerate the location of all the sewers projected for this district, as they appear in the plans, and aggregate lengths are carried into the tabular exhibit forming a part of this report.

The smallest lateral sewers are to be 8 inches in diameter, and the minimum gradient on which these are to be laid, with but few rare exceptions, is 1 foot in 200 feet.

MISSION FLATS DISTRICT.

The Mission Flats pumping station is to serve the entire region lying south of Howard street to the northern base of Potrero Hills, extending as far westerly as Harrison street, near Fourteenth, and easterly to, and even beyond, Fourth and Kentucky streets.

The treatment of this district is to be the same as that prescribed for Yerba Buena, except that lateral sewers in the un-

improved portions of the district, and not now sewered, are not recommended for immediate construction. The main sewer from south of Channel street will be carried under the open water way of that street to the pumping station in an iron pipe. The location of the pumping station is to be at Fifth and Channel streets, or at some adjacent point.

The greatest depths of mains below City base will here also be 15 feet. The location of all projected sewers and their sizes are shown on Sheet No. 6.

In reconstructing the sewers on Seventh and Sixth streets, they are to be lowered near Market street to improve the drainage, which is at present very defective at those points.

LOWER ISLAIS CREEK DISTRICT.

In Lower Islais Creek District there is a dual treatment recommended. In the several sub-districts which are still without sewers, the collection of sewage in separate conduits is recommended in order to keep the amount to be handled by the pump at a minimum. Where the Combined System is already in service, as in the case of Lower Army street and East Cortland Sub-districts, it is to be retained. The Southwest slope of the Potrero Hills is also to be sewered on the Combined System, as it is naturally directly tributary to the extended Army-street sewer. To what has already been said in the chapter on the North Point District, relating to the Islais Creek District, there is but little to be added. The pumping station is to be centrally located. The lowest elevation at which sewers will enter it will be 15 feet below City base. The force or discharge main from the pump will take a course westerly along Marin street to Vermont street, thence northerly to Army street, westerly to Utah street extended, and thence northerly along Utah street to Sonoma street, where delivery will be made into a gravity main which follows Sonoma street westerly to the North Point main.

The total lift from the pumping station to the end of the discharge main will be a little over 50 feet at a mean stage of water in the receiver at the pump.

In this district, as in the case of Mission Flats, the sewers projected for improved territory are not recommended for imme-

diate construction, except in the case of mains which are now needed. Where sewers recommended for construction fall upon streets crossing the marsh and not now graded, it has been assumed that these would be ordered improved as a matter of urgency, and that within a few years they would be ready to receive the sewers. Attention is again called to the fact that some of the grades of the streets crossing Islais Flats have been established at impracticable elevations, notably in the case of Fifteenth avenue South, the grades of which are 1 foot below City base for a considerable distance. A change to a proper grade that will make drainage feasible will manifestly be in the interest of adjacent property. The sewers included in the cost estimate whose alignment is along such streets as Loomis and others, now unimproved marsh surface, are not to be constructed until suitable grades have been established and the streets shall have been graded.

The storm-water drainage of this district has been studied. It is foreseen that the order in which improvements are made and in which streets are filled to grade will affect the position of submains. These have not, therefore, all been shown in the plan. They would not, even if shown, have been included in the work now recommended for construction. The main drainage line of the Islais Creek Valley is shown, together with required dimensions. It should be constructed in the near future whenever a fair extent of the streets of the region served shall have been filled.

THE NORTH POINT MAIN SEWER.*

The North Point main sewer is an intercepter of unusual length and importance. In its upper portion it is the main sewer of the Upper Islais Creek District, which extends beyond the southerly line of the City. Its upper end is at Ocean View, serving as an intercepter for the sewage of the southern slope of the Ocean View hills; the country tributary to it in this vicinity extending as far west as Orizaba avenue. In its upper section it is the main sewer of the sub-district, "County Line West." The main sewer may be said to commence at the intersection of Capitol and Sadowa streets. Its course is thence northeasterly along the valley streets of the Upper Islais Creek region, or along the

(* See Plate No. 6.)

lines on which valley streets should be opened, to the point where Islais Creek is crossed by Mission road. As the sewer receives tributaries, some of which are the mains of the various subdistricts—County Line East, Sunny Side, Glen Park, Persia Avenue and Silver Avenue West—it gradually increases in size, reaching the Mission road with a diameter of nine and one-half (9½) feet. The street grade at this point is about 102 feet above City base; the bottom of the sewer in Springdale street, just before it reaches the Mission road, is to be at eighty-six (86) feet. The bottom of the culvert now in service under the road is at about seventy-five (75) feet. This culvert is to remain in use and will ultimately become a part of the relief conduit required down stream along Islais Creek channel from this point to the Bay.

On Springdale street, just above Mission road, a relief outlet is to be built into the side of the sewer, so arranged that sewage proper and the run-off due to a rain of one-quarter inch in 24 hours will remain in the main sewer, while all excess storm waters will drop into a lower conduit over a spillway, or weir, and, passing under Mission road, will reach Islais Creek.

The project now presented indicates dimensions of the conduit required down the Islais Creek Valley from this point, and also suggests the location for a valley street at points of the creek where lands are not yet subdivided.

The arrangement of Mission road is such that 27.00 second-feet of sewage and surface drainage will be retained in the main sewer, while all excess storm-water flow, estimated at 751 second-feet for an assumed future population of 40 per acre, and fairly well-improved streets, will be sent during the prevalence of rain-storms, down the Islais Creek Valley. The storm-water conduit down this valley should not be constructed until the march of improvement makes the putting of the storm-water drainage into a conduit a necessity.

Passing the Islais Creek relief outlet, the main sewer will enter a tunnel following the course of Mission road and San Jose avenue a distance of very nearly 4,500 feet, to a point near Twenty-ninth street.

Concerning the portion of the North Point main sewer above this tunnel, it is to be said that, although many of the streets along which it takes its course are not yet graded, and some are

not even laid out, that this main is still of such vital importance to the healthful development of this region, which embraces over 2,600 acres, that provision should be made to cover the cost of its construction in the bond issue. It has, therefore, been included among the sewers recommended for immediate construction, and in the estimate of cost. It is believed that by the time the more important lower section of the main sewer can be carried out, the principal streets of the Upper Islais Creek District will be ready to receive the sewer.

The sewer, after issuing from its tunnel on San Jose avenue, near Twenty-ninth street, will follow San Jose avenue to Army street. The combined flow of the North Point main and of Upper Army-street sewer will flow thence in the Army-street sewer one block to Valencia street, or rather to a point just above this street, where a second storm-water relief outlet is to be arranged in such a way that all ordinary sewage, including the usual allowance of rain water, will turn to the north into Valencia street, while the excess flow of storm water will be dropped over a weir into a parallel conduit leading back into the present Army-street sewer at Valencia street, and will be carried by this sewer to Islais Creek. The required capacity of the main sewer southward is 37 second-feet. The relief outlet is to be given a capacity of 350 second-feet.

The flow of the main will, in this vicinity, be augmented by the sewage from West Bernal Heights, as well as by that of the Upper Army-street and Valley-street District. Its course is along Valencia street to Twenty-sixth, thence along Twenty-sixth to Treat avenue, along Treat avenue to Twenty-fifth, to Alabama, and thence along this street northward from Twenty-fifth to Nineteenth, where it will turn westward along Nineteenth, with a short offset toward the north at Harrison, again reaching Treat avenue. It will follow Treat avenue to Eighteenth street, there joining the Eighteenth-street main sewer and reaching the upper end of what may be called the lower section of the North Point main, the gradient of which is controlled to this point by the elevation of the street surface. Southward from Eighteenth street the sewer is not controlled in elevation by a flat grade line, but takes the steeper gradients generally indicated by street surface elevations.

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At Eighteenth street is the upper end of the existing big Channel-street sewer, which follows Division street to Ninth, and is thence extended in the form of a temporary wooden box.

Advantage is to be taken of this large sewer by delivering into it at Eighteenth street the excess storm-water flow of the North Point and Eighteenth-street mains combined.

The top of the outflow weir at this point is to be at elevation 4.20 feet above City Base, which represents the elevation of the hydraulic grade line or high-water stage in the sewer.

In order that this elevation may not be greatly exceeded, it is proposed to give the overflow weir considerable length.

Before reaching Eighteenth street the main sewer will have received accessions to its flow from the Islais Creek pumping station, from the Twenty-second Street District and from the west slope of Potrero Hills.

The ultimate maximum excess flow through the Eighteenth-street relief outlet is estimated at 650 second-feet; the ordinary maximum flow of sewage with the rain water due to one-quarter inch of rain in 24 hours, below Eighteenth street, is 70 second-feet.

Along Division street, from Eighteenth to Sixteenth, the North Point main is to parallel the Channel-street sewer in close contact with it.

Southward from Sixteenth street the sewer will follow Harrison street. At Fifteenth street the main storm-water flow of the Fourteenth-street District will reach the North Point sewer. Here it is proposed to arrange another storm-water relief outlet. The excess flow of storm-water will take the course of the present lower end of Fifteenth-street sewer, also reaching Channel-street sewer.

At Fourteenth street the remainder of the drainage of the Fourteenth-street District will enter the main. Here, too, a spill-wall will enable the excess storm-water flow to find an outlet toward the east into the conduit now in service along the subsurface right of way, held by the City, from Harrison to Channel street along the extended line of Fourteenth street. At Fourteenth, Fifteenth and Eighteenth streets there will be scant head room for the structures required if their tops be arched. It is

therefore proposed to cover the required space on the plan of a bridge floor supported by heavy steel beams.

From Fourteenth to Eleventh street the sewer will be on Harrison, taking the curve of the street. It will receive the drainage of the Eleventh-street District at Eleventh street, and here another storm-water relief is to be provided, the arrangement being of the usual type. The excess flow will enter a conduit at the lower side of the main, falling over a weir; this conduit will turn into Tenth street and discharge either into the head of Brannan-street sewer or into Channel-street sewer just above the point where Brannan-street sewer leaves it.

At Ninth street the North Point main will receive from the southeast the sewage and restricted rain water drainage from the East Potrero District, this intercepter having been previously relieved of its excess storm-water flow. It will turn from Harrison northwesterly into Eighth street, and thence northeasterly into Howard, following Howard street to New Montgomery street. All along Howard street the sewer will lie between the tracks of the cable car line. It will be crossed at Seventh, Sixth and Fifth streets by the sewers of these streets, which will pass over its top. Each of these is to carry only the excess storm-water flow below Howard street, sewage proper and a limited amount of surface drainage being in each case admitted to the main sewer. To accomplish this result it is proposed to arrange storm-water reliefs in these sewers just above Howard street, and to let the restricted flow of sewage drop into the lower lying North Point main. The sewers now on these streets below Howard street will discharge into Brannan-street sewer. They will not receive sewage proper which will be collected by a separate system of sewers.

After the main sewer turns into New Montgomery street, it will follow this street and Montgomery street to the water-front, and will be carried northwesterly along the water-front to near the foot of Dupont street, where a deflection will be made toward the northeast to the outfall in the Bay.

At Mission street there is to be a storm-water relief with overflow height at the hydraulic grade line. At this point the main sewer will be crossed by the local sewers, which will deliver sewage and storm-water, together with the drainage from the

north slope of Rincon Hill, into a sewer returning westerly along Mission street from Second to New Montgomery.

From near Stevenson street, on New Montgomery street, to Bush and Montgomery streets, the depth of the sewer below the surface of the street will be so great that it will be desirable to treat this as a tunnel section. This will have the great advantage over open trench work of not disturbing traffic on Market street during the construction.

From Bush street to a short distance beyond Jackson street the sewer is to be constructed in open trench. There will be a storm-water relief outlet on Commercial street and another on Jackson street.

At or near Jackson street the sewer will enter a tunnel piercing Telegraph Hill but following the alignment of Montgomery street. The tunnel will be about 2,500 feet long, all in firm metamorphic rock, quite hard, yet not difficult to cut through.

North of the tunnel, to a point about midway between Lombard and Chestnut streets, the sewer will lie in firm material and may be constructed in open cut, but further northward and along the water-front the sewer will be in wet and unstable ground. The plan and cross-section shown on Plate No. 13 are typical of the proposed sewer construction in this section.

The sewer is to be circular, 8 feet in diameter below Jackson street, and is projected of concrete and brick. It is to be supported in bad ground by piles. Sheet piling in double rows on each side are to facilitate trenching. The piles used as guide piles for the sheeting are to remain as part of the foundation, and the two lines of sheeting are to form the side walls of the box for shaping the concrete. Iron rods are to add strength to the concrete, and additional piles are to be driven and capped with the concrete of the invert in such a way as to give the structure proper support.

The tunnel sections are to be brick and concrete-lined. All other sections of the main sewer are to be circular, concrete being used for the invert and brick for the arch.

The dimensions of the sewer are tabulated and need not be repeated in the text, but attention may be called to the fact that in those sections of light gradient where the hydraulic grade line

falls one foot in 2,600 it is to be circular, with a diameter of 6 feet at Eighteenth street and increased as follows:

At Fourteenth street, from 6 feet to 6½ feet.
At Eleventh street, from 6½ to 7 feet.
At Sixth street, from 7 to 7½ feet.
At Jackson street, from 7½ to 8 feet.

The grade of the invert is steeper than that of the hydraulic grade line. It is as follows:

1 in 1,800 from Eighteenth to Eleventh street.
1 in 1,900 from Eleventh to Sixth street.
1 in 2,000 from Sixth street to the screen-house on the water-front.

These increased gradients of the invert give the sewage greater velocity, as the sewer is emptied on each falling tide and during the reduced flow of the dry weather period.

Near the foot of Dupont street the outfall section of the North Point main will begin. The brick and concrete sewer will terminate in a screen-house, from which two large pipes, each 60 inches in diameter, will take the sewage to the outfall point under the waters of the Bay. The screen-house is to be located either on the seawall or at the end of a solid bulkhead or pier, the construction of which has been recommended by Chief Engineer Mr. Howard Holmes, of the Harbor Commission, and the location of which would be such that the brick sewer, supported on piles, could be carried along its western edge to its extremity, and the screen-house should in that event be located at the outer end of this bulkhead.

The outfall pipes are to be laid either parallel or slightly divergent, as may hereafter be determined, and are to be imbedded in the sand of the Bay and covered with concrete. The discharge is to be through several openings at and near the ends of the pipes, in order that the sewage may be well diffused in the Bay currents. In the case of a solid bulkhead or a pier from which to extend pipes, they will discharge in water about 40 feet deep, and a strip of clean Bay water 400 feet wide will intervene between the end of the solid fill and the point of discharge, which would,

if the pier be made 1,000 feet long, as proposed, be about 1,400 feet from the harbor front line.

In case the pipes begin at a screen-house on the seawall, then the pipes are to be extended off shore 1,200 feet and will terminate in water about 50 feet deep. These depths of water are noted for low tide.

The screen-house should be a substantial brick building, supported on a pile foundation, equipped with screens for intercepting particles of cork and the like floating on the surface of the sewage. Each compartment may be used as a settling chamber, from which sand or other silt reaching it can be removed by means of a centrifugal pump, as in the case of hydraulic dredging.

The main sewer will reach the screen-house with its invert at 12.9 feet below City Base. The receiver, if it may be so called, should be one or more circular wells sunk in the method of sink-caissons for ferry slip piers, and lined inside with brick. The cost estimated includes two such circular wells, each 16 feet in diameter and connected together, from each of which an outfall pipe is to start. Alongside of the main sewer, just before it enters the receiver, is to be a long spill-way, or overflow weir, at the high-tide line, over which any excess flow of storm-water may discharge into a low flat conduit of brick or concrete leading directly to the Bay.

The discharge of the Mission Flat pumping station will reach the North Point main at Fifth street. This pumping station is to be located at or near Fifth and Channel streets, as nearly central to the district to be served as possible.

Sewage proper and cellar drainage will ultimately reach this station from an area of about 845 acres. The main sewers, as they converge towards the receiver at the pump, will be at a considerable depth below street surface, the extreme being 15 feet below City Base. This pumping station will afford considerable relief to some of the low sections near Division and Thirteenth and Fourteenth streets.

Throughout the entire Mission Flat District it is proposed to restrict use of the present sewers to storm-water run-off, condensor water and discharges from bathing tanks and to put all sewage into the separate sewers. The entire cost of the separ-

ate system has been included in the cost estimated, together with an allowance for remodeling the main storm-water drains, in order to eliminate the many depressions in sewer bottoms, which now give them the character of elongated cesspools.

The Yerba Buena District is to receive a treatment exactly similar to that of the region southward from Howard street. Sewers for sewage only are to be laid so deep that cellars can be drained. The main sewers are to converge toward a central point somewhere near Drumm street, preferably between Sacramento and Commercial streets, where a covered receiver is to be located, from which sewage is to be pumped into the North Point main on Montgomery street.

The estimate of cost includes an allowance for the remodeling of the sewers now in service in the Yerba Buena and Mission Flat Districts, so that they may serve efficiently as storm-water drains. In many cases this will require building in of a new bottom, and sometimes a partial filling of the old structure. The principal requirement in each case will be to give the sewer a well constructed invert on a continuous downgrade.

The Lower Islais Creek District, at variance with others, is to be sewered in part on the combined system, in part on the separate system. The reason for this is that a large part of the district is already sewered, and no good reason is apparent for abandoning sewers already in service. This is notably true of the region tributary to Lower Army-street sewer and of East Cortland Avenue District.

These sub-districts, and also the western portion of the southern slope of Potrero Hills, are to be sewered on the combined system, while the eastern portion of the southern slope of Potrero Hills, an entirely new section, and the lower flat marsh lands of Islais Creek are to be sewered by sewers on the separate system.

The district lies at and below the junction of Precita and Islais Creeks, extending, however, a considerable distance up the valley of each creek. Army-street sewer now discharges across private property at San Bruno Road into Islais Creek. This sewer is to be extended to the pumping station, which will be located on a point of rock which projects well out toward the bank of the creek between Arkansas and Connecticut streets. At

that point the dry weather flow of sewage will be discharged into a receiver, also the flow in winter when the rainfall limit is not exceeded. At other times, that is, during rainstorms of considerable intensity, the discharge will be into the creek.

In the case of the Cortland-avenue sewer, a storm-water relief is to be introduced so that only sewage and a limited quantity of rain water will reach the receivers at the pumping station. Storm waters of this district will be received into separate conduits and delivered into Islais Creek.

An important intercepting sewer, which will reach the North Point main at Ninth and Harrison streets, is the East Potrero District sewer. This intercepter will begin on the south side of the Potrero Hills, on Twenty-second and Missouri, has an easterly course to Kentucky, follows Kentucky to Nineteenth, Nineteenth to Tennessee, Tennessee to Eighteenth, Eighteenth to Minnesota, Minnesota to Mariposa, Mariposa to Mississippi, Mississippi to Seventeenth, Seventeenth to Rhode Island, Rhode Island to Sixteenth, Sixteenth to San Bruno avenue, this avenue to Division and Ninth streets and Ninth street to Harrison.

At Twenty-second and Kentucky streets there is to be a storm-water relief outlet, also at Carolina, on Seventeenth, and below Alameda on San Bruno Avenue. This entire sewer is recommended for immediate construction. This sewer will be iron-stone pipe, at its upper end 15 inches in diameter, increasing to 21, then to 24, and changing to brick at Pennsylvania avenue. It will egg-shaped, 3 feet by 4 feet 6 inches to Indiana street, and thence 3 feet 6 inches by 5 feet 3 inches to Kentucky street, where a storm-water relief outlet with a capacity of at least 57 second-feet will relieve it of any excess storm-water flow. Thence, the sewage, with a limited amount of surface drainage, will flow northerly in a 15-inch, and then 18-inch, pipe to Nineteenth and Tennessee streets, and in a 21-inch pipe to Eighteenth street; thence in a brick sewer, egg-shaped, 2 feet by 3 feet, to Minnesota and Mariposa streets. The sewer will be 3 feet by 4 feet 6 inches to Pennsylvania; thence to Carolina and Seventeenth streets, 3 feet 6 inches by 5 feet 3 inches. At that point the relief outlet will have a capacity of 30 second-feet, and the main will be continued as a circular sewer of concrete and brick 4 feet 6 inches in diameter to Rhode Island street, 5 feet in diameter

to Sixteenth and Rhode Island and 5 feet 6 inches in diameter to Alameda street, where the last storm-water relief outlet is to have a capacity of 83 second-feet. Sewage proper and surface drainage together, to the amount of 5 second-feet, will then enter a 24-inch pipe leading directly to the North Point main.

The storm-water overflow at Twenty-second and Kentucky streets will be carried in a brick conduit along Kentucky street southward for a short distance and discharged into the Bay. This conduit is to be extended from time to time as improvements east of Kentucky street may require.

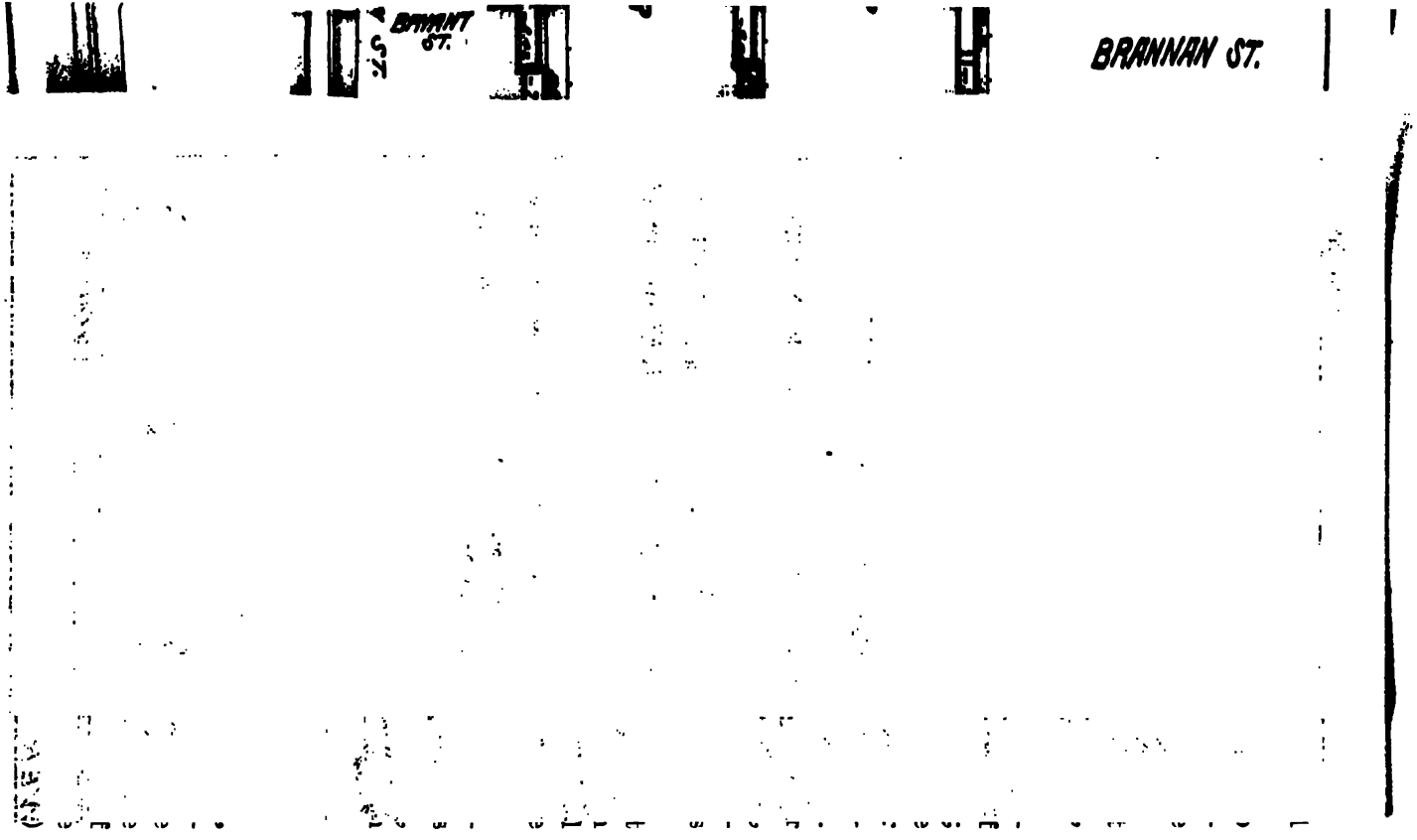
The storm-water discharge at Seventeenth and Carolina streets is to be carried in a brick conduit northerly along Carolina to Fifteenth street, along Fifteenth to De Haro, along De Haro to Berry, and along Berry to a connection with the Channel-street storm-water conduit.

The third relief outlet will discharge into a short conduit leading northerly also into the Channel-street storm-water conduit.

Eleventh-street District and Seventh-street District border upon each other along a line not defined by topographical features, but arbitrarily assumed, giving to each sewer the district most readily sewered by existing works. In closing the sewers easterly which now drain from the Eleventh-street District into the Seventh-street District, it is proposed to arrange some of these closings as storm-water reliefs or emergency outlets, to serve only in extreme cases and only during the life of the sewers of the Eleventh-street system, which are now of sufficient capacity, but which are to be replaced in the indefinite future.

There will be but little sewer-building required for the Fifth, Sixth and Seventh-street mains. However, the service they have rendered in the past has been very unsatisfactory. The sewers on Seventh and Sixth streets should be reconstructed from Market street to Howard, being placed deeper below the street surface. The principal improvement in the service of these sewers will be the result of restricting and properly proportioning the area tributary to each.

In North Beach, Portsmouth, Fifth, Sixth, Seventh and Eleventh-street sub-districts, the principal requirement aside from the construction of a few short mains, will be the restriction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of drainage to definite district lines. It will be necessary to abolish many sewer crossings by closing one of two and sometimes two out of three sewers which now all descend from one manhole in as many different directions.

The cutting out of sewers along all district and sub-district boundary lines will be necessary for all districts already sewered, and provision for this work is made in the cost estimate.

The largest sections of the North Point main are to be circular. All circular sewers of large diameter are to be built of concrete and brick. The invert of the sewer is to be concrete; the arch brick. In wet and yielding ground the sewer is to be supported on piles. All sewers less than 24 inches in diameter are to be of iron-stone pipe. Iron-stone pipe would also be preferred for still larger diameters if obtainable at reasonable cost. For all sewers exceeding the capacity of a pipe 2 feet in diameter and less than that of a circular sewer 4 feet 6 inches in diameter, the egg-shape is to be preferred. The greatest internal horizontal dimension of egg-shaped sewers has been taken at two-thirds of the vertical diameter.

These notes as to sewer types apply to all mains, except that in the case of those pipe sewers of the Yerba Buena and Mission Flats Districts, which are deep below the street surface and will be in unstable ground, a special support on piles and outside concrete protection is made the basis of the cost estimate.

Special attention is called to the fact that where acre property is not yet laid out in streets and blocks, a number of streets have been suggested which are required to facilitate drainage, and the need for which should not be overlooked when such lands are subdivided for sale.

FOURTEENTH-STREET DISTRICT MAINS.

In projecting main sewers for the Fourteenth-street District, it was found that on account of the low grades of the street surface it would be well nigh impossible to build a conduit large enough along Fourteenth street to take the entire drainage of the tributary area. It was therefore decided to make a partition of this drainage at Fourteenth and Market streets, sending the major portion of the sewage and storm-water (about 70 per cent.)

southward along Church street to Fifteenth, and along this street to the North Point main. The higher position of Fifteenth street affords better gradients, smaller sewers are required, and full advantage can be taken of the better sewers already on Fourteenth street. Another advantage will be in the better facilities for the arrangement of a relief outlet of large capacity where Fifteenth-street sewer enters the main than at Fourteenth street.

It is to be said, however, that the partition of waters into two mains is not to be treated as an ordinary relief outlet, but should be so arranged that it will at every stage divide the flow proportionally.

CHANNEL-STREET CONDUIT AND OTHER CONDUITS FOR EXCESS STORM-WATER.

Channel-street sewer, as now in service, commences at Eighteenth street and extends along Division street (sometimes called New Channel street) to Ninth, where it discharges into a temporary wooden box sewer. The dimensions of this sewer are gradually increased from about 7 by 5 feet at its upper end to 11 feet by 9 feet at Ninth street.

The size of conduit required to accommodate the excess storm-water on the line of this sewer is shown on the plan.

It is recommended that at this time the Channel-street sewer be kept in service for the restricted use of relieving the North Point main during storms, and that it be extended to Seventh street at Channel of the full size ultimately required, 20 feet wide by 9 feet high. The cost of this extension, as a structure supported on piles, is included in the cost estimate.

Brannan-street sewer is to be repaired in its tunnel under the south slope of Rincon Hill, and is to have its gradient corrected. Besides being the main storm-water drain south of Market street, it is to be the recipient of the excess storm-water flow along Seventh, Sixth, Fifth and Fourth streets, and at all of these streets, in its south side, are to be emergency relief outlets to Channel street.

The storm-water conduits on Jackson and Commercial streets are to unite on East street and have a common outlet through

the seawall. Except for the ebb and flow of the tide in them they will be in service only during storms.

HUNTER'S POINT DISTRICT.

Area, 2,300 acres.

Estimated future population to be served, 86,300.

The sewage from the northern slope of the hills south of Islais Creek, eastward from Mission Road crossing, including the University Mound or Upper Bay View region, will be made tributary to a main intercepting sewer skirting the northern base of these hills and terminating at Hunter's Point.

Practically, all of the ridge which terminates at Hunter's Point will be made tributary to this sewer.

The Hunter's Point District embraces the following subdistricts:

College Homestead on the Combined System.
St. Mary's on the Combined System.
South Bernal Heights on the Combined System.
University Mound on the Combined System.
North Silver Terrace on the Combined System.
North Silver Heights on the Combined System.
Railroad Avenue on the Combined System.
North slope of Hunter's Point on the Combined System.
South slope of Hunter's Point on the Combined System.
Bay View, Separate System, sewage only.

The north slope of Hunter's Point will be directly tributary to the main, while the south slope sewage will be intercepted by two mains uniting at F street South, and penetrating the ridge from south to north in a tunnel about 1,500 feet long. This sewer will also receive the sewage from the separate system of the Bay View District, delivered into it by a pump at the intersection of Twentieth avenue South and J street South.

The Hunter's Point sewer is to take care of both the storm-water and sewage of the district which is tributary to it, with the sole exception that the Bay View District will contribute sewage only. As in the case of the North Point main, so in the case of this one, a number of storm-water relief outlets are to be provided so that the size of the sewer may not become excessive.

The storm-water discharged from this sewer in its upper s tions will be delivered into the main storm-water sewer of Isl Creek Valley. The relief near its lower end will be by short possible routes into the Bay.

University Mound District, which might also be called Upp Bay View District, can be made to drain either easterly throu Bay View District proper, or northward, as has been pr ferred, into the Hunter's Point main sewer. By the latt arrangement a speedy delivery of its sewage at Hunter's Poi can be effected. The former would complicate the matter preventing sewage from fouling the waters of the cove south Hunter's Point.

The collection of sewage from the Bay View District shou be by the separate system of sewerage, because in this way t advantage of satisfactory drainage and the disposal of sewa can be most speedily realized, and for the further reason that b complete separation of storm-water from sewage proper, t fouling of the cove south of Hunter's Point will be entirely p vented.

This system of sewerage will be the least expensive in t matter of first installation as well as operation. Under eitl system the sewage would have to be pumped from some cent low point to the main sewer of the south slope of Hunte Point, through which it is to reach the Hunter's Point main.

The district is at present sparsely populated and habitatic are widely scattered, but it is a growing district, and the ea construction of the necessary main sewers for it is recommend and their cost has been included in the estimate.

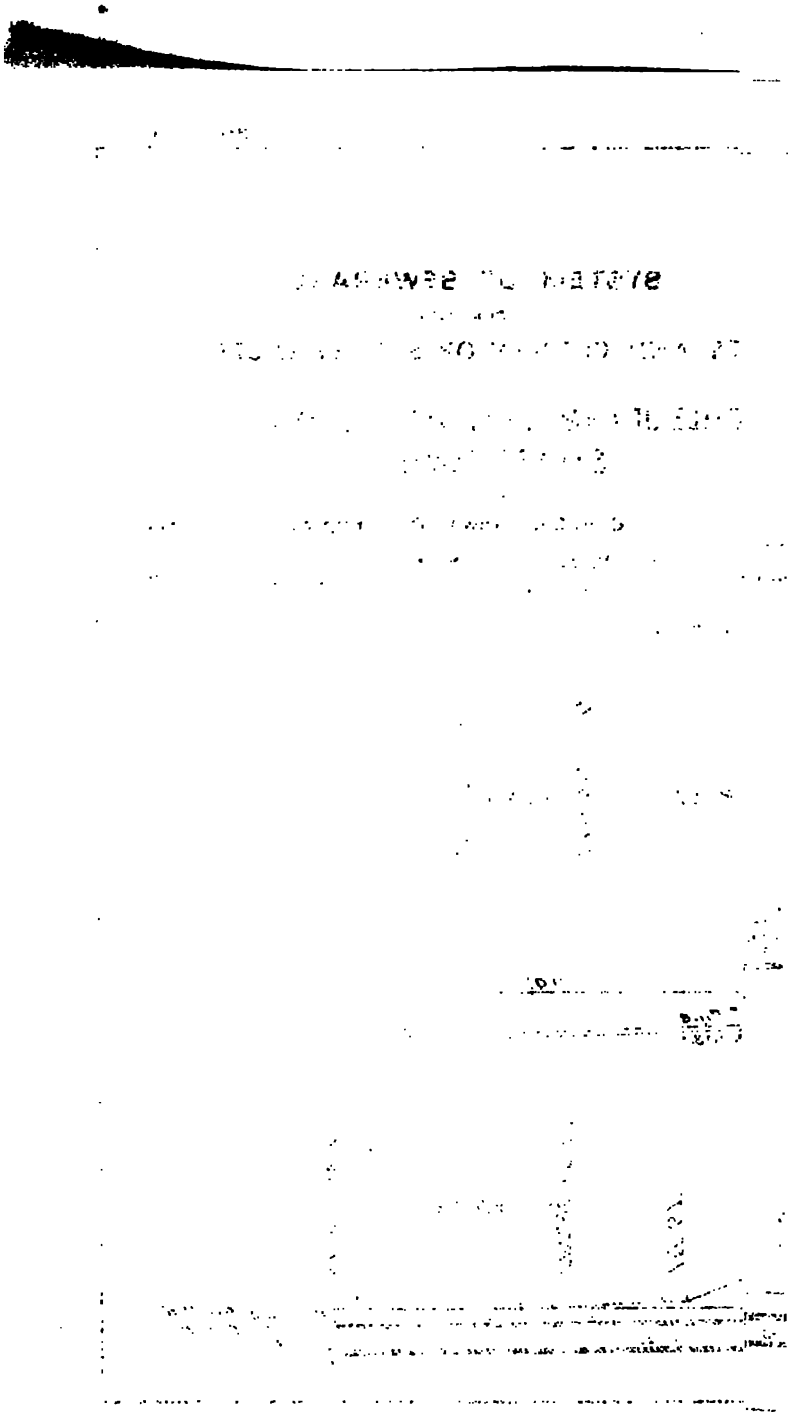
HUNTER'S POINT MAIN SEWER.*

The Hunter's Point main sewer is second in importance o to the North Point main, but it will serve a district that in entirety is still very sparsely settled, and in some portions which grades must be revised to make drainage practicable.

The project involves delivery of sewage at Hunter's Poi but it is not feasible to reach the extreme point at this time.

The improvement of streets along the northern base of t Point, eastward of Kentucky street, seems to be so far in t

(* See Plate No. 6.)



to Sixteenth and Rhode Island and 5 feet 6 inches in diameter to Alameda street, where the last storm-water relief outlet is to have a capacity of 83 second-feet. Sewage proper and surface drainage together, to the amount of 5 second-feet, will then enter a 24-inch pipe leading directly to the North Point main.

The storm-water overflow at Twenty-second and Kentucky streets will be carried in a brick conduit along Kentucky street southward for a short distance and discharged into the Bay. This conduit is to be extended from time to time as improvements east of Kentucky street may require.

The storm-water discharge at Seventeenth and Carolina streets is to be carried in a brick conduit northerly along Carolina to Fifteenth street, along Fifteenth to De Haro, along De Haro to Berry, and along Berry to a connection with the Channel-street storm-water conduit.

The third relief outlet will discharge into a short conduit leading northerly also into the Channel-street storm-water conduit.

Eleventh-street District and Seventh-street District border upon each other along a line not defined by topographical features, but arbitrarily assumed, giving to each sewer the district most readily sewered by existing works. In closing the sewers easterly which now drain from the Eleventh-street District into the Seventh-street District, it is proposed to arrange some of these closings as storm-water reliefs or emergency outlets, to serve only in extreme cases and only during the life of the sewers of the Eleventh-street system, which are now of sufficient capacity, but which are to be replaced in the indefinite future.

There will be but little sewer-building required for the Fifth, Sixth and Seventh-street mains. However, the service they have rendered in the past has been very unsatisfactory. The sewers on Seventh and Sixth streets should be reconstructed from Market street to Howard, being placed deeper below the street surface. The principal improvement in the service of these sewers will be the result of restricting and properly proportioning the area tributary to each.

In North Beach, Portsmouth, Fifth, Sixth, Seventh and Eleventh-street sub-districts, the principal requirement aside from the construction of a few short mains, will be the restriction

of drainage to definite district lines. It will be necessary to abolish many sewer crossings by closing one of two and sometimes two out of three sewers which now all descend from one manhole in as many different directions.

The cutting out of sewers along all district and sub-district boundary lines will be necessary for all districts already sewered, and provision for this work is made in the cost estimate.

The largest sections of the North Point main are to be circular. All circular sewers of large diameter are to be built of concrete and brick. The invert of the sewer is to be concrete; the arch brick. In wet and yielding ground the sewer is to be supported on piles. All sewers less than 24 inches in diameter are to be of iron-stone pipe. Iron-stone pipe would also be preferred for still larger diameters if obtainable at reasonable cost. For all sewers exceeding the capacity of a pipe 2 feet in diameter and less than that of a circular sewer 4 feet 6 inches in diameter, the egg-shape is to be preferred. The greatest internal horizontal dimension of egg-shaped sewers has been taken at two-thirds of the vertical diameter.

These notes as to sewer types apply to all mains, except that in the case of those pipe sewers of the Yerba Buena and Mission Flats Districts, which are deep below the street surface and will be in unstable ground, a special support on piles and outside concrete protection is made the basis of the cost estimate.

Special attention is called to the fact that where acre property is not yet laid out in streets and blocks, a number of streets have been suggested which are required to facilitate drainage, and the need for which should not be overlooked when such lands are subdivided for sale.

FOURTEENTH-STREET DISTRICT MAINS.

In projecting main sewers for the Fourteenth-street District, it was found that on account of the low grades of the street surface it would be well nigh impossible to build a conduit large enough along Fourteenth street to take the entire drainage of the tributary area. It was therefore decided to make a partition of this drainage at Fourteenth and Market streets, sending the major portion of the sewage and storm-water (about 70 per cent.)

southward along Church street to Fifteenth, and along this street to the North Point main. The higher position of Fifteenth street affords better gradients, smaller sewers are required, and full advantage can be taken of the better sewers already on Fourteenth street. Another advantage will be in the better facilities for the arrangement of a relief outlet of large capacity where Fifteenth-street sewer enters the main than at Fourteenth street.

It is to be said, however, that the partition of waters into two mains is not to be treated as an ordinary relief outlet, but should be so arranged that it will at every stage divide the flow proportionally.

CHANNEL-STREET CONDUIT AND OTHER CONDUITS FOR EXCESS STORM-WATER.

Channel-street sewer, as now in service, commences at Eighteenth street and extends along Division street (sometimes called New Channel street) to Ninth, where it discharges into a temporary wooden box sewer. The dimensions of this sewer are gradually increased from about 7 by 5 feet at its upper end to 11 feet by 9 feet at Ninth street.

The size of conduit required to accommodate the excess storm-water on the line of this sewer is shown on the plan.

It is recommended that at this time the Channel-street sewer be kept in service for the restricted use of relieving the North Point main during storms, and that it be extended to Seventh street at Channel of the full size ultimately required, 20 feet wide by 9 feet high. The cost of this extension, as a structure supported on piles, is included in the cost estimate.

Brannan-street sewer is to be repaired in its tunnel under the south slope of Rincon Hill, and is to have its gradient corrected. Besides being the main storm-water drain south of Market street, it is to be the recipient of the excess storm-water flow along Seventh, Sixth, Fifth and Fourth streets, and at all of these streets, in its south side, are to be emergency relief outlets to Channel street.

The storm-water conduits on Jackson and Commercial streets are to unite on East street and have a common outlet through

the seawall. Except for the ebb and flow of the tide in them they will be in service only during storms.

HUNTER'S POINT DISTRICT.

Area, 2,300 acres.

Estimated future population to be served, 86,300.

The sewage from the northern slope of the hills south of Islais Creek, eastward from Mission Road crossing, including the University Mound or Upper Bay View region, will be made tributary to a main intercepting sewer skirting the northern base of these hills and terminating at Hunter's Point.

Practically, all of the ridge which terminates at Hunter's Point will be made tributary to this sewer.

The Hunter's Point District embraces the following subdistricts:

College Homestead on the Combined System.
St. Mary's on the Combined System.
South Bernal Heights on the Combined System.
University Mound on the Combined System.
North Silver Terrace on the Combined System.
North Silver Heights on the Combined System.
Railroad Avenue on the Combined System.
North slope of Hunter's Point on the Combined System.
South slope of Hunter's Point on the Combined System.
Bay View, Separate System, sewage only.

The north slope of Hunter's Point will be directly tributary to the main, while the south slope sewage will be intercepted by two mains uniting at F street South, and penetrating the ridge from south to north in a tunnel about 1,500 feet long. This sewer will also receive the sewage from the separate system of the Bay View District, delivered into it by a pump at the intersection of Twentieth avenue South and J street South.

The Hunter's Point sewer is to take care of both the storm-water and sewage of the district which is tributary to it, with the sole exception that the Bay View District will contribute sewage only. As in the case of the North Point main, so in the case of this one, a number of storm-water relief outlets are to be provided so that the size of the sewer may not become excessive.

The storm-water discharged from this sewer in its upper s tions will be delivered into the main storm-water sewer of Isl Creek Valley. The relief near its lower end will be by short possible routes into the Bay.

University Mound District, which might also be called Upp Bay View District, can be made to drain either easterly throu Bay View District proper, or northward, as has been p ferred, into the Hunter's Point main sewer. By the lat arrangement a speedy delivery of its sewage at Hunter's Poi can be effected. The former would complicate the matter preventing sewage from fouling the waters of the cove south Hunter's Point.

The collection of sewage from the Bay View District shou be by the separate system of sewerage, because in this way t advantage of satisfactory drainage and the disposal of sewa can be most speedily realized, and for the further reason that by complete separation of storm-water from sewage proper, t fouling of the cove south of Hunter's Point will be entirely pr vented.

This system of sewerage will be the least expensive in th matter of first installation as well as operation. Under eithe system the sewage would have to be pumped from some centr low point to the main sewer of the south slope of Hunter Point, through which it is to reach the Hunter's Point main.

The district is at present sparsely populated and habitation are widely scattered, but it is a growing district, and the early construction of the necessary main sewers for it is recommended, and their cost has been included in the estimate.

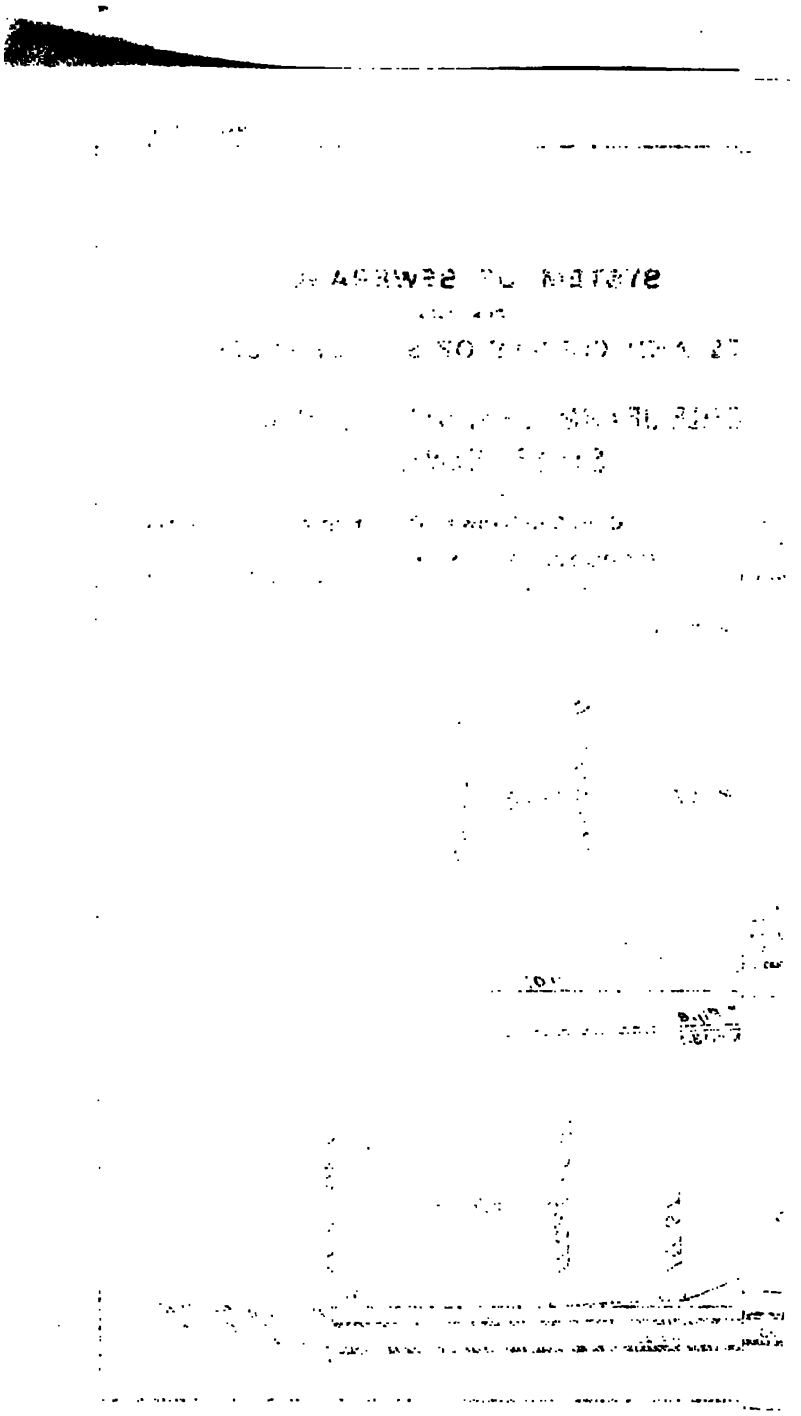
HUNTER'S POINT MAIN SEWER.*

The Hunter's Point main sewer is second in importance only to the North Point main, but it will serve a district that in its entirety is still very sparsely settled, and in some portions of which grades must be revised to make drainage practicable.

The project involves delivery of sewage at Hunter's Point, but it is not feasible to reach the extreme point at this time.

The improvement of streets along the northern base of the Point, eastward of Kentucky street, seems to be so far in the

(* See Plate No. 6.)



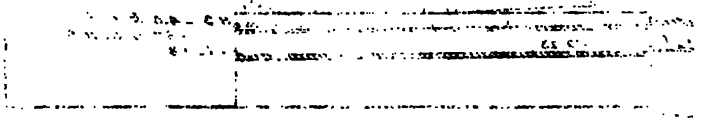
demnation suits, or to locate the sewer on streets that lie in the marsh, and would require grading to almost prohibitive heights.

The sewer at the point where it leaves the valley line of Islais Creek, about midway between Mission Road and San Bruno road, will be an 18-inch pipe for about 800 feet; its size will then be increased to 24 inches, and it will reach Boylston street as a 2 feet by 3 feet sewer. This portion of the sewer is to be located along a hillside street, which should be laid out on the lines shown in the plans.

Below Boylston street the sewer will follow Sweeney street easterly, being now 3 feet by 4 feet 6 inches, it will turn northerly along Barneveld avenue to Gaven street, and will be joined by the University Mound sewer on San Bruno Road. Here a relief outlet will be arranged, discharging excess storm-water into Islais Creek until the projected valley drain can be put in; then a conduit is to be extended from the relief outlet to this drain. The Hunter's Point sewer eastward from San Bruno Road will be 3 feet by 4 feet 6 inches in tunnel along a route already described. Emerging from the tunnel on S street South, the sewer will follow this street to Seventeenth avenue South, this avenue to R street South, R street South to Fifteenth avenue South, Fifteenth avenue South to O street South, O street South to Fourteenth avenue South, Fourteenth avenue South to P street South, P street South to Tenth avenue South, and this avenue to Railroad avenue and N street South, where a sub-main will reach it from the south. Along this route the sewer is increased in size from the egg-shaped 3 feet 6 inches by 5 feet 3 inches sewer to a circular sewer 5 feet 6 inches in diameter.

At some points of this route the cutting will be heavy, but it has been indicated in preference to a route nearer the marsh to avoid the delays incident to accomplishing grade changes which would then be desirable to make such alternative route feasible.

Eastward from Railroad avenue the sewer will follow N street South to Seventh avenue South, Seventh avenue South to M street South, M street South to Sixth avenue South, Sixth avenue South to L street South, L street South to Fifth avenue, Fifth avenue southeasterly to H street South, just before reaching which a temporary outfall is to be established; thence southwest-



VISITACION VALLEY.

Visitacion Valley is a suburban district lying partly within the limits of the City, and partly in San Mateo County. It is sparsely populated, and has but a small portion of its area laid out in blocks and streets. It would be premature to now commit this City to any scheme of collecting and disposing of the sewage of that district.

HARBOR VIEW DISTRICT.

Area, 801 acres.

Estimated future population to be served, 48,100.

Black Point and the ridge connecting it with the main range of hills paralleling the northern frontage of the City, is the western limit of the northernmost portion of the district tributary to the North Point main sewer.

Harbor View District lies to the westward of Black Point, extending from there to the Presidio and from the Bay shore southward to the summit of the Russian Hill ridge and Pacific Heights. Parts of this district are already densely populated, while others, originally marsh surface and beach lands, are but now being reclaimed. The principal sewers now in this district are the Fillmore and the Pierce-street sewers, which discharge into the basin which was cut off from an arm of the Bay by the grading of Lewis street. Communication between this land-locked basin and the Bay is now kept up by a temporary cut through the fill on Lewis street, which ameliorates somewhat the evil effects of discharging a large volume of sewage into a stagnant pool of water. In this district a main outfall sewer along Scott street has been projected and the existing sewers are made tributary to it. It is proposed to extend the combined system of sewerage throughout the district and to concentrate the ordinary flow of sewage in the outfall main.

Storm-water reliefs are also to be introduced where necessary with a special view of bringing existing sewers into service to their full capacity, and letting the excess storm-water flow escape by direct routes into the Bay. If this plan were not followed it would be necessary to reconstruct many of the sewers already in

service. The sewers of this district are projected with special reference to the present condition of improvements. The intercepting sewers, therefore, follow streets along which immediate construction is possible. As the improvement of the water-front property is carried further out into the Bay a second line of intercepting sewers of small capacity will be necessary. The storm-water relief conduits will serve as local sewers below the upper intercepting line until they reach the water-front, where their ordinary flow will follow the lower intercepter and be carried toward the selected main outfall point.

At each extreme high tide during the winter there will be some outflow along this frontage of extremely dilute sewage through the storm-water reliefs, which are to be arranged to commence to act at the elevation of ordinary high tide. No such discharge need take place during the dry weather period, as these relief outlets may then be kept entirely closed, or open only to inflowing water.

The discharge is to be effected through a large pipe about 800 feet long which will terminate in the Bay in water about 40 feet deep. The strong currents along the northern shore, the depth below Bay surface at which the sewage is discharged, and the broad strip of clean salt water intervening between the point of disposal and the shore line will render such discharge harmless and inoffensive. Not enough of the sewage to be detected by sight or smell will ever reach the shore line. Whenever the improvement of the low flat portions of this district shall have been advanced to such extent as to make drainage to a depth of 8 or 10 feet below the street surface desirable, then a separate system of sewers can be introduced for the collection of sewage only. The arrangement of this separate system is to be adapted to the conditions which are found to prevail at the time it is to be installed.

Presidio Heights is a small sub-district tributary to the Harbor View main. The main sewer from this sub-district now has a direct course through the southeast corner of the Presidio Reservation from Locust to Union streets, most of the way in tunnel. The pipe sewer now in service is somewhat deficient in capacity, but may be kept in service until storm-water overflow

at the south line of the Presidio at Locust street becomes objectionable.

RICHMOND DISTRICT.

Area, about 1,200 acres.

Estimated future population to be served, about 60,000.

Richmond District embraces the area south of the Presidio, west of the Bay drainage and north of the Park, except the area in the southwest portion, which cannot drain by gravity to the Twenty-seventh avenue outfall, and which is designated later on as West Richmond District.

A sewer project was adopted some years ago for the Richmond District on the Combined System and having a gravity outfall at the west end of Twenty-seventh avenue. The greatest portion of this system having been constructed, it is to be adhered to and the outfall extended into deep water and utilized for the separate systems of the Ocean front districts.

A careful inspection of the Twenty-seventh avenue outfall and of the adjacent shore line failed to show any visible trace of sewage, nor could any odor whatever be detected, although the discharge was little below the line of low water and immediately on the shore line. The strong tidal currents which sweep this part of the shore warrant its use as a point of disposal. It is therefore proposed to extend the outfall into deeper water, so as to utilize this outfall for the sewage of Ocean Front District until it shall become advisable to utilize a more desirable point northerly from Point Lobos. The main sewers not yet constructed in Richmond District are recommended for construction and are included in the cost estimate.

DISTRICTS OF THE OCEAN SLOPE OF THE PENINSULA.

The topography of the western or ocean slope of the peninsula necessitates a division into four sewerage districts, as follows:

West Richmond.

Upper Sunset.

Lower Sunset.

Ocean View.

The last named district extends to the county line.

The property around and including Lake Merced is as yet not subdivided, and no provision is made for sewers in this area, as the City should not assume the responsibility of prescribing sewers until streets have been projected through this private property. When the necessity arises for sewering this district it should be upon principles similar to those prescribed for the other portions of the ocean frontage.

The run-off from this entire slope is very slight; the soil being principally blown sand into which the heaviest rainfall soaks without run-off. Two small streams occur, Lobos Creek, near the northerly limit, and the creek formed by the overflow from Lake Merced. The rest of the natural drainage is underground by gradual percolation into the Ocean along the sand beach south of Point Lobos.

The only desirable outfalls available for the Ocean frontage are, for reasons already stated, along the tide-swept precipitous shore at or east of Point Lobos. Hence, sewage and drainage from the districts into which it is subdivided must receive special treatment, and the system of collection and disposal must be such as will most economically serve the growing and ultimate needs of the districts, and at the same time rigidly conform to the restrictions previously mentioned as necessary to preserve the beach from contamination. Although the areas now built up are comparatively small and widely separated, each is in need of sewerage to prevent fouling the soil and sub-soil waters of adjacent lands which are to become homes or which serve for the present as catchment areas for domestic water supply.

The Ocean front districts southward from Point Lobos have very small populations as compared with their areas, and long distances have to be traversed to the selected point of outfall.

For these reasons, and for those previously mentioned relating to the necessity of protecting the beach from contamination, the separate system of sewage collection and disposal is prescribed for all of the districts of this portion of the peninsula. The sewage from all of the districts except that from Upper Sunset District, which can be given a gravity outfall, is to be delivered to a receiver and pumping station on Forty-ninth avenue, near Fulton street. From this station it will be pumped into a gravity main discharging at the west end of Twenty-seventh ave-

nue. Whenever the volume of sewage at this station shall become too great to economically use this outfall, a much lower and more economical outfall must then be provided by a low level tunnel about 5,200 feet long to a point just north of Point Lobos, where a submerged pipe will deliver the sewage into deep water and strong tidal currents off-shore. When this shall become advisable, part of the sewage of these districts may then be intercepted by a gravity main delivering directly into the tunnel, and the remainder will be discharged through the same tunnel by the pumping station now recommended.

The storm-water conduits of the West Richmond and of the Sunset districts are to be at less depth below the street surface than the sewers for sewage only. These storm-water drains at the points where they cross the main sewers will be so arranged that their dry weather flow, if there be any, shall be delivered into the mains of the Separate System.

Such an arrangement is desirable, because during the dry weather months more or less street refuse will necessarily find its way into these conduits, and the washing of sidewalks and soil drainage may contribute enough water to keep up a trickling summer flow which would not be desirable to deliver upon the beach. A connection as proposed will also put the first run-off at the commencement of the winter rains into the separate sewers, so that the storm-water drains will be fairly clean before they flow out upon the beach.

WEST RICHMOND DISTRICT.

Area, 483 acres.

Estimated future population to be served, 19,200.

West Richmond District is that portion of the Ocean frontage north of the Park, which is so situated as to be cut off from gravity drainage into the Twenty-seventh avenue outfall. Sewage is to be collected by a main on Fulton street, commencing at Thirty-sixth avenue, as a 10-inch pipe sewer, and increasing to 12-inch pipe sewer at Forty-third avenue and continues to the receiver on Forty-ninth avenue near Fulton street. It will receive 8-inch local sewers or laterals at the upper end and at each intersecting street as they become necessary.

The storm-water run-off of this district is to be collected in a main conduit having a westerly course along Fulton street at the

northern line of Golden Gate Park. This drain or sewer may be called a main from Thirty-second avenue westerly. It will be joined at Forty-second avenue by a branch from the north, which from Thirty-seventh avenue to Forty-second is the main for C street. It will also receive the drainage from B street by a branch which will extend along that street from Fortieth avenue to the Ocean Highway and southerly along this Highway to Fulton street. The outfall of this sewer will necessarily be into the Ocean, but, as already explained, the small summer soil drainage and the first winter run-off are to be taken into the sewers for sewage proper. The lower sections of these storm-water drains will be the usual egg-shape, 3 feet 6 inches by 5 feet 3 inches.

UPPER SUNSET DISTRICT.

Area, 1,658 acres.

Estimated future population to be served, 64,200.

This district embraces that portion of the Ocean front south of the Park and west of the divide between the Bay and Ocean drainage, from which the sewage can be intercepted on H street at Twenty-ninth avenue and delivered by gravity in a closed pipe across the Park into a main leading to the Twenty-seventh avenue outfall. The storm-water drainage of this district is to be collected in a separate system of conduits, utilizing the existing sewers for this purpose and delivered into the Ocean with those of Lower Sunset District at J street.

The sewage of this district is to be collected by a main commencing on M street at Seventh avenue, thence down Seventh avenue to H street, where it is joined by the local sewer on H street above Seventh avenue and extends as a 12-inch main down H street to Tenth avenue, thence 15-inch to Eleventh, and 18-inch to Fifteenth, 21-inch to Thirtieth street. Here it crosses the Park in a closed pipe and discharges into the gravity main at D street and Twenty-seventh avenue, leading to the Twenty-seventh avenue outfall.

LOWER SUNSET DISTRICT.

Area, 2,564 acres.

Estimated future population to be served, 98,600.

This district embraces the main western slope of the Ocean

frontage southward from the Park to near Lake Merced. The greater portion is unimproved sand dunes through which streets have been projected, but in which official grades have not yet been established.

It is premature to commit the City to a definite alignment of sewers for this district, but it has been necessary to outline a location for main and lateral sewers to which grades can be fitted when the construction of sewers shall become expedient; these locations can be modified if found necessary. Sewage is to be collected in a main along Ocean Highway, which main also receives sewage from Ocean View District and delivers it into the receiver of the West Richmond District at or near Fulton street and Forty-ninth avenue, from which it is to be pumped into a gravity main at Fulton street and Twenty-seventh avenue, thence following this main to the Twenty-seventh avenue point of disposal.

Whenever the expense of pumping from this receiver, which serves for West Richmond, Lower Sunset and Ocean View Districts, shall justify the work, this delivery is to be changed to the more desirable point of disposal north of Point Lobos and reaching it by a tunnel, as already described.

Storm-water from Upper and Lower Sunset Districts is to be collected into three main intercepting conduits having two points of outfall in the Ocean. The first of these is to be on H street, turning southerly on Ocean Highway to J street, thence westerly into the Ocean; the second is northerly on Ocean Highway from Q street to the J-street outfall; the third is along X street (or a parallel street as future grades may determine) to the Ocean near the west end of X street.

As elsewhere noted, the existing sewers in the Upper Sunset District are to serve as parts of the storm-water drainage system. The sewer along H street will be circular, 6 feet in diameter, being an extension of the 6-foot sewer now discharging both storm-water and sewage into a sandy depression south of the Park. It is proposed to locate this sewer near the curb line of the street in order to avoid interference with the pole line of the electric railway.

OCEAN VIEW DISTRICT.

Area, 783 acres.

Estimated future population to be served, 29,800.

Ocean View District is the area sloping westward from the peninsula ridge toward Laguna de la Merced. It embraces Lake View and Ingleside. It is a district which is but sparsely populated except in the immediate vicinity of Ocean View and Ingleside, but which requires immediate attention because its drainage is toward the laguna which is still used as a source of water supply for this City, and should be kept free from contamination by sewage. Aside from this fact it is to be remembered that this district lies upon the slope toward the Ocean and should, therefore, receive a similar treatment as recommended for West Richmond and Lower Sunset Districts, in order that no sewage from it may reach and foul the beach. The plan of treatment to be adopted for this district is suggested by its probable development. Storm-waters must necessarily follow natural drainage lines westward with ultimate outfall into the Ocean and can, whenever necessary, be diverted past Lake Merced, as has already been done in the case of waters reaching this lake from the south.

Sewage is to be collected and delivered by the Separate System to a closed main located on a hydraulic grade line, the upper end of which is at about elevation 160, which will discharge into a sewer to be laid along the Ocean Road to the south end of the main on Ocean Highway, and thence to the common receiver and pumping station for all the sewage of the Ocean frontage.

The collecting or intercepting sewer will be largely upon the private lands of the Spring Valley Water Works. It should take a fairly direct course, as indicated on Sheet No. 10, to the Ocean Road, crossing the two ravines on trestles. It is proposed to make this sewer of cast-iron at all points where it is exposed and would otherwise be liable to injury.

The last section of the sewer, along that part of Ocean Road which lies below grade of the Ocean Highway is also to be of cast-iron.

The storm-water drains that will hereafter be required for Ocean View District are not shown in the plans, because they

are not recommended for immediate construction, and only their upper ends fall within areas that are already subdivided. There will be two main lines; one following the valley line through the race-course property at Ingleside, and the other commencing at the eastern end of Stanley street. Both of them are to be extended across the unsubdivided lands of the Spring Valley Water Works along lines not to be determined until the property is subdivided.

GENERAL ARRANGEMENT OF PUMPING STATIONS.

The arrangement of the machinery and of the receivers at the various pumping stations has received special consideration. The detail of this part of the work has been in direct charge of H. C. Behr, Mechanical Engineer, and the conclusions as presented were reached in conference with him.

The following tabulated data relate to the required capacity and lift of the several pumping plants:

	Yerba Buena.	Mission Flats.	Lower Islais Creek.	Bay View.	West Richmond.
Capacity, Ultimate Maximum—Second-feet	5.8	14.4	12.2	5.0	30*
Capacity, Ultimate Average—Second-feet	4.2	9.6	8.0	3.5	24
Capacity, Ultimate Required—Second-feet	6.	15.	12.	5.	30
Capacity, Present Required—Second-feet	1+2+2	2+3+5	1+2+3	1+1	1+1
Head in Feet, Maximum	31	35	65	30	182
Head in Feet, Ultimate					30
Horse-power, Ultimate	42	120	180	35	137
Horse-power, Present	35	80	88	14	42
Receiver Capacity, Gallons	60,000	60,000	60,000	40,000	40,000
Length of Force-Main, Feet	2,100	4,000	4,700	1,650	6,650
Dimension of Force-Main, Inches	16	18	18	8	8
Area Required for Plant, Feet	50x120	50x137½	75x100	50x180	50x120

*This maximum (as well as some of the other values in this column) is somewhat arbitrarily assumed and will probably never be attained, before a high level intercepter for portions of Ocean View, Sunset, and West Richmond districts, discharging by gravity into the tunnel to the Lobos Point outfall, will reduce the volume to be handled by pump to less than half of these figures.

Centrifugal pumps are the best adapted for handling sewage, and they are recommended for all of the stations except West Richmond, where, owing to high lift, vertical, crank-driven, triple plunger pumps are to be used. Here, too, however, the use of centrifugal pumps is taken into consideration for installment as soon as a low-level delivery at Point Lobos is to be effected.

The pumps at some of the stations, notably those of the Bay frontage, will have to be placed below high tide level. Suitable provision is to be made in such cases to surround them with water-tight housing.

The arrangement throughout at the several stations is to be in units such that any receiver or any individual pump can be thrown out of service without interfering with pumping operations.

Receiver capacities have been fixed to some extent on the basis of available territory, and can be added to if occasion should hereafter arise.

The receivers for each pumping station are shown as triplicate tanks or vertical cylinders interconnected. Each one is connected with the sewer with an independent pump suction and with an overflow to a nearby storm-water conduit. This arrangement is suggested in order to secure sufficient reservoir capacity, and at the same time to overcome difficulties of construction known to exist at such stations as Yerba Buena, Mission Flats and Bay View, and the cylindrical form of receiver is best adapted for this purpose. It will be necessary at these stations to use piles by reason of the unstable foundations to give support to the receivers and machinery.

The sewage before entering the receivers is to be screened. Ventilation is to be provided by means of a ventilating shaft or chimney in which a small fan blower with a multiple injector nozzle is to create a draft.

All pumps are to be belt driven, as this arrangement has many advantages over direct connections for the variable work required at each station.

Small units are suggested for the pumps in order to secure greatest possible adaptability to all requirements.

The matter of motive power has been carefully considered,

and the conclusion reached that gas, oil and electric motors are all well suited for this work. Steam is not advisable on account of space required, increased cost of attendance, the smoke nuisance, and, in some cases, intermittent character of work.

The desirability of being independent of fuel supply suggests the use of an internal combustion engine similar to the Diesel Motor, which can be operated either with crude oil, domestic petroleum or city gas. An oil or gas engine can always be replaced by an electric motor, which would require even less floor space, so that it does not seem wise to take into consideration any land purchase such as would be required to make the future installation of a steam plant possible.

The equipment at each station is to be complete, including fireproof housing and such conveniences as cranes for handling machinery and the like. The force or discharge main from each pumping station is to be of cast-iron.

In preparing the estimate of cost a liberal allowance has been made for the uncertain nature of the ground into which the receivers are to be built, the possible extent of the required pile foundations, cost of excavating, value of real estate and the present uncertainty of the price of materials, notably in the case of iron.

The details of the arrangements shown on Plate No. 14 are tentative, but the estimate of cost covers a complete installation, not, of course, including alternative power motors, which may in the future become desirable.

The maintenance of the sewer system after the same is completed will be far less expensive than at present, except in the matter of the improved service secured by pumping. The cost of operating the pumps will be about $18,000 per year when the system is completed. This cost of operation does not include the interest and depreciation account. It will increase with increasing population (notably in the outlying districts) to about $2,500 per month when the anticipated population of one million shall have been reached.

TABULAR EXHIBIT OF PROPOSED SEWER MAINS.

In order to indicate clearly which sewers are recommended for early construction the following table has been prepared which supplements the data presented in the plans. The esti-

mate of cost covers the construction of all of the sewers which are recommended for immediate construction even in those cases where streets are not now ready to receive them and where several years may elapse before their construction.

The principal sewer types which were made the basis of the cost estimate are shown on Sheet No. 14.

The information in the tables relating to sewer sizes is given in detail so far as definiteness could be given to the location of sewers, except in the following cases:

In the case of Yerba Buena District, all sewers as shown on Sheet No. 5 forming a complete system of sewers for the collection of sewage proper are recommended for immediate construction and are covered by the cost estimate.

In the case of Mission Flats District the entire system of sewers as projected is not shown on Sheet No. 6, which is now submitted for the purpose of showing the sewers recommended for immediate construction. These sewers shown embrace the entire system of sewers for sewage proper except a few local sewers on unimproved water-front property, and embrace also the sewers at once required south of Channel street.

In the case of Lower Islais Creek District the sewers for sewage proper are shown on Sheet No. 7, but only to the extent that they are now recommended for construction.

All of the structures and devices of every kind, including manholes, connections with old sewers, relief outlets, pumping stations and outfall works which are necessary for the successful operation of the sewers now recommended for construction are to be considered a part of these sewers and are not specifically enumerated in the following table, but are covered by the estimate of cost.

Abbreviations used in the table are as follows:

N—North or northerly.

S—South or southerly.

E—East or easterly.

W—West or westerly.

Brick means either brick, or concrete and brick.

I. S. P.—Iron-stone pipe.

Req.—Required.

Pro.—Proposed.

Prod.—Produced.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
NORTH POINT DISTRICT. **MAIN SEWER.**						
*Mission Road and San Jose ave.	Islais creek	N. end tunnel	4500	Tunnel.	3′ x4′6″	
*San Jose ave.	N. end tunnel	Valley st	62	Brick...	3′ x4′6″	
*San Jose ave.	Valley st.	Army st	1230	Brick...	3′6″x5′3″	
*Army st.	San Jose ave.	Valencia st.	300	Brick...	6′	5′
*Valencia.	Army st	Twenty-sixth st.	330	Brick..	2′6″x3′9″	
*Twenty-sixth	Valencia st.	Howard st	1260	Brick..	3′ x4′6″	
*Twenty-sixth	Howard st	Treat ave.	950	Brick...	3′ x4′6″	
*Treat ave	Twenty-sixth st.	Twenty-fifth st.	580	Brick...	3′ x4′6″	
*Twenty fifth st.	Treat ave.	Alabama st.	580	Brick..	3′ x4′6″	
*Alabama st.	Twenty-fifth st.	Nineteenth st.	3390	Brick...	4′6″	
*Nineteenth st.	Alabama st.	Treat ave.	680	Brick...	4′6″	
*Treat ave.	Nineteenth st.	Eighteenth st	585	Brick...	5′6″	
*Division st.	Eighteenth st.	Sixteenth st.	1120	Brick...	6′	
*Harrison st.	Sixteenth st.	Fourteenth st.	1180	Brick...	6′	
*Harrison st.	Fourteenth st.	Eleventh st.	800	Brick...	6′6″	
*Harrison st.	Eleventh st.	Eighth st.	1600	Brick...	7′	
*Eighth st.	Harrison st.	Howard st.	1260	Brick...	7′	
*Howard st.	Eighth st.	Sixth st.	1800	Brick...	7′	
*Howard st.	Sixth st	New Montgomery	3300	Brick...	7′6″	
*New Montgomery	Howard st.	Market st.	1200	Brick...	7′6″	
*Montgomery st.	Market st.	Jackson st.	2810	Brick...	7′6″	
*Montgomery st.	Jackson st.	S. end of tunnel.	190	Brick...	8′	
*Montgomery st.	S. end of tunnel.	N. end of tunnel.	2500	Tunnel.	8′	
*Montgomery st.	N. end of tunnel.	Water Front	1190	Brick...	8′	
*Water Front.	Montgomery st.	Dupont st.	1050	Brick...	8′	
*Outfall pipes	Water Front.	Point of disposal	1200	Cast ir'n	2 — 60″	
NORTH BEACH SUB-DISTRICT						
‡Mason st.	Vallejo st.	Green st.	344	I. S. P..		1
‡Mason st.	Green st.	Bay st.	2356	Brick...		3′ x5′
*Mason st.	Bay st.	North Point st.	345	Brick...	5′	3′ x5′
‡Powell st.	Vallejo st.	Francisco st.	2400	Brick...		3′ x5′
‡Powell st.	Francisco st.	North Point st.	690	Brick...	3′6″x5′3″	3′ x5′
*Powell st.	North Point st.	Beach st.	345	Brick...	6′	3′ x5′
*Beach st.	Powell st.	North Point main	950	I. S. P..	15″	
*Powell st. overflow.	Beach st.	to Sea wall	500	Brick..	6′	3′ x5′
‡Bay st.	Larkin st.	Leavenworth st.	950	I. S. P..		1
*Bay st.	Leavenworth st.	Jones st.	480	I. S. P..	24″	1
*Bay st.	Jones st.	Taylor st.	480	Brick...	2′ x3′	1
*Bay st.	Taylor st.	Mason st.	480	Brick...	3′ x4′6″	1
‡Battery st.	Broadway st.	Filbert st.	1400	Brick...		3′ x5′
*Battery st.	Filbert st.	Lombard st.	690	Brick...	3′ x4′6″	3′ x5′
*East st.	Lombard st.	Chestnut st.	500	I. S. P..	12″	
*Chestnut st.	East st.	Montgomery st.	500	I. S. P..	12″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.
† Not recommended for immediate construction. ‖ Wood.
** To be retained in part.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
PORTSMOUTH SUB-DISTRICT.						
‡Dupont st.	California st.	Sacramento st.	345	Brick.		3′ x5′
‡Dupont st.	Sacramento st.	Washington st.	690	Brick.	3′ x4′6″	3′ x5′
‡Dupont st.	Washington st.	Jackson st.	345	Brick.		3′ x5′
‡Jackson st.	Dupont st.	Montgomery st.	350	Brick.		3′ x5′
‡Montgomery ave.	Broadway st.	Kearny st.	450	Brick.		3′ x5′
‡Kearny st.	Montgomery ave.	Jackson st	300	Brick.		3′ x5′
RINCON HILL SUB-DISTRICT.						
*Tehama st.	First	Second st.	900	Brick.	2′6″x3′9″	
*Second st.	Tehama st.	Howard st.	280	Brick.	2′6″x3′9″	
*Mission st.	Second st.	New Montgomery st.	300	I. S. P.	12″	
FIFTH STREET SUB-DISTRICT.						
‡Turk st.	Hyde st.	Market st.	2050	Brick.		3′ x5′
‡Eddy st.	Jones st.	Powell st.	1400	Brick.		3′ x5′
‡Market st.	Turk st.	Fifth st.	250	Brick.		3′ x5′
‡Market st.	Dupont st.	Powell st.	1200	Brick.		3′ x5′
*Powell st.	Eddy st	Market st.	100	Brick.	3′6″x5′3″	3′ x5′
*Market st.	Powell st.	Fifth st.	200	Brick.	4′6″	3′ x5′
*Fifth st.	Market st.	Howard st	1230	Brick.	5′	3′ x5′
SIXTH STREET SUB-DISTRICT.						
‡Golden Gate ave.	Polk st.	Larkin st.	480	Brick.		3′ x5′
*Golden Gate ave.	Larkin st.	Jones st.	1440	Brick.	3′ x4′6″	12″, 3′x5′, 14″ & 18″
‡Golden Gate ave.	Jones st.	Taylor st.	480	Brick.		3′ x5′
*Sixth st.	Market st.	Howard st.	1350	Brick.	3′ x4′6″	3′ x5′
SEVENTH STREET SUB DISTRICT.						
‡McAllister st.	Gough st.	Jones st.	3400	Brick.		3′ x5′ 3′ x5′6″ 3′ x5′
*Market st.	Jones st.	Seventh st.	325	Brick.	3′6″x5′3″	3′ x5′
*Seventh st.	Market st.	Howard st	1280	Brick.	3′6″x5′3″	
ELEVENTH STREET SUB-DISTRICT.						
‡Pierce st.	California st.	Sutter st.	1032			3′ x5′
‡Sutter st.	Pierce st.	Steiner st.	481	Brick.	3′ x4′6″	3′ x5′
‡Sutter st.	Steiner st.	Fillmore st.	481	Brick.	4′6″	3′ x5′
‡Fillmore st.	Sutter st.	Post st.	344	Brick.	4′6″	3′ x5′
‡Fillmore st.	Post st.	Turk st.	1720	Brick.	5′	3′ x5′
*Turk st.	Fillmore st.	Webster st.	481	Brick.	5′6″	3′ x5′

* Recommended for immediate construction. ‡ Existing sewer to remain in use.
† Not recommended for immediate construction.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
ELEVENTH STREET SUB-DISTRICT—CONTINUED.						
*Webster st.	Turk st.	McAllister st.	688	Brick...	5′6″	3′ x5′ 12″x 14″
*McAllister st.	Webster st.	Buchanan st	481	Brick...	5′6″	3′ x5′
*McAllister st.	Buchanan st	Laguna st.	481	Brick...	6′	3′ x5′
*Laguna st.	McAllister st.	Grove st.	688	Brick...	6′	3′ x5′
*Grove st.	Laguna st.	Octavia st.	481	Brick...	6′	3′ x5′
*Octavia st.	Grove st.	Oak st.	1032	Brick...	6′	16″, 18″ and 14″
*Oak st.	Octavia st.	Market st.	1650	Brick...	6′	3′ x5′
*Eleventh st.	Market st.	Folsom st.	1850	Brick...	6′	3′ x5′
*Buchanan st.	Bush st.	Post st.	688	I. S. P..	24″	16″, 18″, 14″x18″
*Buchanan st.	Post st.	Geary st.	344	Brick...	2′ x3′	18″
*Buchanan st.	Geary st.	O'Farrell st.	344	Brick...	2′6″x3′9″	14″
‡Buchanan st.	O'Farrell st.	McAllister st.	1720	.....	.....	3′ x5′
‡Webster st.	Sutter st.	Turk st.	2064	.....	.....	3′ x5′
‡Steiner..	Sacramento st.	Sutter st.	1360	.....	.....	3′ x5′
‡Polk st.	Fulton st.	Market st.	1032	.....	.....	3′ x5′
‡Market st	Polk st.	Eleventh st.	375	.....	.....	3′ x5′
‡Grove st.	Gough st.	Franklin st.	481	.....	.....	3′ x5′
‡Franklin st.	Grove st.	Hayes st.	344	.....	.....	3′ x5′
‡Hayes st.	Franklin st.	Van Ness ave.	500	.....	.....	3′ x5′
‡Van Ness ave.	Hayes st.	Oak st.	688			
FOURTEENTH STREET SUB-DISTRICT.						
*Fulton st.	Masonic ave.	Lyon st.	962	Brick...	2′6″x3′9″	18″
*Fulton st.	Lyon st.	Devisadero st.	1413	Brick...	3′ x4′6″	18″
*Devisadero st.	Fulton st.	Grove st.	344	Brick...	3′ x4′6″	18″
‡Devisadero st.	Grove st.	Hayes st.	344	Brick...	3′ x4′6″	3′ x5′
‡Devisadero st.	Hayes st.	Fell st.	344	Brick...	3′ x4′6″	3′ x5′
‡Oak st.	Clayton st.	Scott st.	3840	.....	.....	3′ x5′
*Stanyan st.	Sullivan st.	Frederick st.	688	Brick...	2′ x3′	16″
*Stanyan st.	Frederick st.	Beulah st.	344	Brick...	2′6″x3′9″	16″
*Stanyan st.	Beulah st.	Fell st.	1376	Brick...	3′ x4′6″	16″
*Oak st.	Stanyan st.	Cole st.	952	Brick...	3′ x4′6″	16″
*Fourteenth st.	Noe st.	Sanchez st.	650	I. S. P..	21″	14″
*Fourteenth st.	Sanchez st.	Church st.	650	Brick...	2′ x3′	18″
*Church st.	Fourteenth st.	Fifteenth st.	640	Brick...	5′6″	3′ x5′
*Fifteenth st.	Church st.	Howard st.	3200	Brick...	5′6″	14″, 18″, 3′ x5′
*Fifteenth st.	Howard st.	Harrison st.	1250	Brick...	7′	3′4″x5′
*Waller st.	Ashbury st.	Clayton st.	481	I. S. P..	24″	....
*Waller st.	Clayton st.	Cole st.	600	Brick...	2′ x3′	
‡Cole st.	Carl st.	Waller st.	1040	.....	.....	3′ x5′
‡Cole st.	Waller st.	Oak st.	1170	Brick...	3′ x4′6″	3′ x5′
*Cole st.	Oak st.	Fell st.	344	Brick...	3′6″x5′3″	
‡Fell st.	Cole st.	Devisadero st.	3848	Brick...	4′6″	4′ x5′
‡Fell st.	Devisadero st.	Scott st.	481	Brick...	5′	4′ x5′

* Recommended for immediate construction. ‡ Existing sewer to remain in use.
† Not recommended for immediate construction.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
FOURTEENTH STREET SUB-DISTRICT—CONTINUED.						
‡Scott st.	Fell st.	Waller st.	1376	Brick.	5′	4′ x5′
‡Waller st.	Scott st.	Pierce st.	481	Brick.	5′	4′ x5′
‡Waller st.	Pierce st.	Fillmore st.	962	Brick.	5′6″	5′
‡Fillmore st.	Waller st.	Ridley st.	650	Brick.	5′6″	5′
‡Ridley st.	Fillmore st.	Church st.	220	Brick.	5′6″	5′
‡Church st.	Ridley st.	Fourteenth st.	640	Brick.	5′6″	5′
*Fourteenth st.	Church st.	Towards Guerrero st.	375		3′ x4′6″	5′
‡Fourteenth st.		Guerrero st	450		3′ x4′6″	3′ x5′
‡Fourteenth st.	Guerrero st.	Mission st.	1280		3′ x4′6″	3′ x5′
‡Fourteenth st.	Mission st.	Howard st.	650		3′6″x5,3″	3′ x5′
‡Fourteenth st.	Howard st.	Harrison st.	1280		6′	6′
EIGHTEENTH STREET SUB-DISTRICT.						
‡Eighteenth st.	Danvers st.	Douglas st.	1200			3′ x5′
‡Eighteenth st	Douglas st.	Eureka st.	300	Brick.	2′6″x3′9″	3′ x5′
‡Eighteenth st.	Eureka st.	Noe st.	1620	Brick.	3′ x4′6″	3′ x5′
‡Eighteenth st.	Noe st.	Church st	1270	Brick.	3′6″x5′3″	3′ x5′
*Eighteenth st.	Church st	Mission st.	2600	Brick.	5′6″	3′ x5′
*Eighteenth st.	Mission st.	Division st.	1550	Brick.	6′	3′ x5′
UPPER TWENTY-SECOND STREET SUB-DISTRICT.						
‡Twenty-second st.	Dolores st.	Guerrero st.	640	Brick.	2′ x3′	3′ x5′
‡Twenty-second st.	Guerrero st.	Valencia st.	630	Brick.	2′6″x3′9″	3′ x5′
*Twenty-second st.	Valencia st.	Capp st.	950	Brick.	3′ x4′6″	16″
*Capp st.	Twenty-second st.	Twentieth st.	1170	Brick.	3′6″x5′3″	14″ & 16″, C. P.
*Twentieth st.	Capp st.	Treat ave.	1270	Brick.	3′6″x5′3″	14″ to Howard st.
*Treat ave.	Twentieth st.	Nineteenth st.	580	Brick.	3′6″x5′3″	
EAST POTRERO SUB-DISTRICT.						
*Twenty-second st.	Missouri st.	Texas st.	280	I. S. P.	15″	
*Twenty-second st.	Texas st.	Mississippi st.	280	I. S. P.	21″	
*Twenty-second st.	Mississippi st.	Pennsylvania ave.	290	I. S. P.	24″	
*Twenty-second st.	Pennsylvania ave.	Indiana st.	550	Brick.	3′ x4′6″	
*Twenty-second st.	Indiana st.	Kentucky st.	840	Brick.	3′6″x5′3″	
*Kentucky st.	Twenty-second st.	Twenty-third st.	930	Brick.	3′ x4′6″	
*Kentucky st.	Twenty-third st.	Twenty-fourth st.	500	Brick.	3′6″x5′3″	
*Kentucky st	Twenty second st.	Twentieth st.	930	I. S. P.	15″	‖16″
*Kentucky st.	Twentieth st.	Nineteenth st.	464	I. S. P.	18″	‖18″
Nineteenth st.	Kentucky st.	Tennessee st.	280	I. S. P.	18″	‖
Tennessee st.	Nineteenth st.	Eighteenth st.	464	I. S. P.	21″	‖16″
18th–Minnesota sts.	Tennessee st.	Mariposa st.	744	Brick.	2′ x3′	‖16″
Mariposa st	Minnesota st.	Pennsylvania ave.	850	Brick.	3′ x4′6″	
Mariposa, Mississippi and 17th sts.	Pennsylvania ave.	Carolina st.	2434	Brick.	3′6″x5′3″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.

† Not recommended for immediate construction.

‖ Old sewers not on required grade.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
EAST POTRERO SUB-DISTRICT—CONTINUED.						
*Carolina, Eighth Fifteenth, DeHaro and Berry sts	Seventeenth st	Channel st. sewer	2350	Brick	2′6″x3′9″	
*Seventeenth st	Carolina st	Rhode Island st	550	Brick	4′6″	
*Rhode Island st	Seventeenth st	Sixteenth st	464	Brick	5′	
*Sixteenth st	Rhode Island st	San Bruno ave	830	Brick	5′6″	
*San Bruno ave	Sixteenth st	Alameda st	940	Brick	5′6″	
*San Bruno ave	Alameda st	Channel st. sewer	420	Brick	3′6″x5′3″	
*San Bruno ave. and Ninth st	Alameda st	Harrison st	1980	I. S. P.	24″	
*Mariposa st	Wisconsin st	Carolina st	280	I. S. P.	24″	
*Carolina st	Mariposa st	Seventeenth st	464	Brick	2′6″x3′9″	
*Alameda st	Hampshire st	Potrero ave	290	I. S. P.	18″	
*Alameda st	Potrero ave	Utah st	290	I. S. P.	21″	
*Alameda st	Utah st	San Bruno ave	280	I. S. P.	24″	
WEST POTRERO SUB-DISTRICT.						
*Twenty-fourth st	San Bruno ave	Utah st	280	Brick	2′6″x3′9″	16″
*Twenty-fourth st	Utah st	Alabama st	1640	Brick	3′6″x5′3″	16″, 14″
*Twenty-second st	Potrero st	Hampshire st	280	I. S. P.	24″	
*Hampshire st	Twenty-second st	Twenty-first st	560	Brick	2′ x3′	10″
*Twenty-first st	Hampshire st	Bryant st	520	Brick	2′ x3′	12″
*Bryant st	Twenty-first st	Twentieth st	580	Brick	2′6″x3′9″	12″
*Twentieth st	Bryant st	Florida st	300	Brick	2′6″x3′9″	16″
*Florida st	Twentieth st	Nineteenth st	490	Brick	3′ x4′6″	
*Nineteenth st	Florida st	Alabama st	200	Brick	3′ x4′6″	16″
*Eighteenth st	Potrero st	York st	560	I. S. P.	24″	16″
*Eighteenth st	York st	Harrison st	990	Brick	2′6″x3′9″	14″, 16″
‡Harrison st	Eighteenth st. formerly Solano	Eighteenth st	200	Brick	2′6″x3′9″	3′ x
*Eighteenth st	Harrison st	Division st	300	Brick	2′6″x3′9″	
UPPER ARMY STREET SUB-DISTRICT.						
*Twenty-fourth st	Fountain st	Hoffman ave	315	I. S. P.	24″	
*Twenty-fourth st	Hoffman ave	Douglas st	624	Brick	2′6″x3′9″	
*Twenty-fourth st	Douglas st	Castro st	1280	Brick	3′ x4′6″	
‡Twenty-fourth st	Castro st	Noe st	643	Brick	3′6″x5′3″	3′x
‡Twenty-fourth st	Noe st	Sanchez st	643	Brick	3′6″x5′3″	3′ x
‡Sanchez st	Twenty-fourth st	Twenty-fifth st	584	Brick	4′	4′ x
‡25th, Church and 27th sts	Sanchez st	Dolores st	2461	Brick	4′6″	3′x 5′x5′
‡Twenty-seventh st	Dolores st	Guerrero st	650	Brick	5′	5′x5′
‡Guerrero-Army sts	Twenty-seventh st	San Jose ave	630	Brick	5′	5′x5′
‖Army st	San Jose ave	Valencia st	300	Brick	6′	5′ x5′
‡Diamond st	Twenty-eighth st	Twenty-seventh st	585	I. S. P.	12″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.

† Not recommended for immediate construction.

‖ Recommended for immediate construction from relief outlet.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
UPPER ARMY STREET SUB-DISTRICT—CONTINUED.						
‡Diamond st.....	Twenty-seventh st..	Twenty-sixth st.....	585	I. S. P.	15″	
‡Diamond st	Twenty-sixth st.....	Twenty-fourth st...	1170	I. S. P..	18″	16″
*Eureka and 23d....	Twenty-second st...	Diamond st.....	905	I. S. P..	21″	14″
*Diamond st.....	Twenty-third st.....	Twenty-fourth st...	585	I. S. P..	24″	16″
*Castro st..... ...	Twenty-eighth st ...	Twenty-ninth st....	585	I. S. P..	12″	
*Castro st....	Thirtieth st.....	Twenty-ninth st....	585	I. S. P..	15″	
‡Twenty-ninth st...	Castro st.....	Noe st.....	642	I. S. P..	18″	18″
*Noe st.....	Twenty-ninth st....	Day st.....	290	I. S. P..	21″	16″
*Day st.....	Noe st.....	Sanchez st.....	645	I. S. P..	24″	18″
*Day st.....	Sanchez st.....	Church st.....	645	Brick...	3′ x4′6″	18″
*Church st.....	Day st.....	Twenty-ninth st....	290	Brick...	3′ x4′6″	18″
*29th, Dolores, Valley	Church st.....	San Jose ave.....	1570	Brick...	3′ x4′6″	18″, 16″
*Merced st.....	Harry st.....	Thirtieth st.....	560	I. S. P..	12″	
‡Noe st.....	Thirtieth st..... ...	Day st.....	290	I. S. P..	15″	16″
*San Jose ave.....	French st.....	Randall st.....	780	I. S. P..	15″	
*Randall st.....	Whitney st.....	Chenery st.....	600	I. S. P..	12″	
*Randall st.....	Chenery st.....	San Jose ave.....	440	I. S. P..	15″	
‡San Jose ave.....	Randall st.....	Thirtieth st.....	920	I. S. P..	18″	18″
‡San Jose ave.....	Thirtieth st.....	Twenty-ninth st.....	530	I. S. P..	24″	18″
‡Mission st.....	Highland ave.....	West ave.....	530	I. S. P..	12″	16″
‡Mission st.....	West ave.....	Cortland ave.....	850	I. S. P..	15″	16″
‡Mission st..... ...	Cortland ave.....	Virginia ave.....	880	I. S. P..	24″	24″
*Mission st.....	Virginia ave.....	Precita ave.....	1470	Brick...	2′6″x3′9″	
*Mission st.....	Precita ave.....	Army st	550	Brick...	3′ x4′6″	
*Mission st.....	Army st.....	Twenty-sixth st.....	550	I. S. P..	12″	
*Cortland ave.....	California ave.	Mission st.....	360	I. S. P..	18″	12″
‡Virginia ave.....	California ave.....	Mission st.....	360	I. S. P..	18″	16″
*Coso ave.....	Buena Vista st.....	Bernal ave.....	730	I. S. P..	12″	
*Bernal ave.....	Angle	Coso ave.....	560	I. S. P..	15″	
*Coso ave.....	Bernal ave.....	Precita ave.....	310	I. S. P..	15″	
*Precita ave.....	Coso ave.	Mission st.....	230	I. S. P..	21″	
UPPER ISLAIS CREEK SUB-DISTRICT—MAIN SEWER.						
*Sadowa st.....	Capitol st.....	San Jose ave.....	1200	Brick...	2′6″x3′9″	
*Sherman and Wyoming aves.....	San Jose ave.....	Naglee ave.	2050	Brick...	2′6″x3′9″	
*Wyoming ave.....	Naglee ave.	Mt. Vernon ave.....	1630	Brick...	3′6″x5′3″	
*East Lake ave., etc	Mt. Vernon ave.. ...	Geneva ave.....	950	Brick...	5′	
*Proposed new street	Geneva ave.....	Seneca ave.....	700	Brick...	5′6″	
*Proposed new street and Cayuga ave...	Seneca ave.....	Ocean ave...	1550	Brick...	6′	
*Proposed new street	Ocean ave.....	Jarnac st., produced	1430	Brick...	6′6″	
*Proposed new street	Jarnac st., produced	Springdale st.....	1150	Brick...	7′	
*Springdale st ..	Last defined point .	Lyell st.....	1000	Brick...	8′	
**Springdale st....	Lyell st.....	Mission st.....	950	Brick...	9′6″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.

† Not recommended for immediate construction.

** Recommended for immediate construction to tunnel.

Character and Dimensions of Required Sewers.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
GLEN PARK SUB-DISTRICT.						
†Twin Peaks ave....	New Market st.....	Duncan st.....	550	I. S. P..	18″	
†Twin Peaks ave....	Duncan st.....	Valley st.....	550	I. S. P..	21″	
†Glen ave.....	Twin Peaks ave.....	Lincoln ave.....	850	I. S. P..	24″	
†Glen ave.....	Lincoln ave.....	Bellevue st.....	700	Brick...	3′ x4′6″	
†Bellevue st.....	Thirtieth st.....	Pforr st., produced..	1950	Brick...	3′ x4′6″	
*Pforr st., produced.	Upper terminus.....	Hamilton ave.....	950	Brick...	3′ x4′6″	
*Pforr st., produced.	Hamilton ave.....	Diamond st.	1000	Brick...	3′6″x5′3″	
*Pforr st., produced.	Diamond st.....	Railroad culvert....	600	Brick...	3′6″x5′3″	
*Lyell st. and the same produced...	Railroad culvert...	Springdale st.....	850	Brick...	3′6″x5′3″	
*Diamond st	Chenery st.....	Pforr st., produced..	350	I. S. P..	24″	
*Cuvier st.....	Railroad.....	Springdale st.....	1100	I. S. P..	18″	
SUNNYSIDE SUB-DISTRICT.						
*Milton avenue, produced, etc.....	Nr Genessee, prod'd.	Havelock st.....	1000	I. S. P..	15″	
*Havelock st.....	Western terminus...	Circular ave.....	740	I. S. P..	18″	
*Havelock st.....	Circular ave.....	San Jose ave.....	1130	I. S. P..	21″	
*San Jose ave.....	Havelock st.....	Jarnac st.....	880	Brick...	2′6″x3′9″	
*Spreckels ave.....	Genessee st.....	Edna st.....	1320	I. S. P .	21″	
*Edna st.–Flood ave.	Spreckels ave.....	Detroit st.....	950	I. S. P..	24″	
*Sunnyside ave.	Gennessee st.....	Foerster st.....	650	I. S. P..	24″	
*Foerster st.....	Thirty-third st.....	Sunnyside ave.....	1600	Brick...	2′ x3′	
*Sunnyside ave., Edna st., Hearst av. and Detroit st	Foerster st.....	Flood ave.....	1860	Brick...	2′6″x3′9″	
*Flood av.–Congo st.	Detroit st.....	Circular ave.....	900	Brick...	3′ x4′6″	
*Jarnac st. and the same produced...	Circular ave.....	Main sewer, prod'c'd	1720	Brick...	3′6″x5′3″	
*Sunnyside ave.....	Baden st.....	Circular av at Fult'n	1150	I. S. P..	18″	
*Proposed new street	Circular ave.....	Springdale st.....	750	I. S. P..	21″	
COUNTY LINE WEST SUB-DISTRICT.						
*Mission st.....	Oliver st	Whittier st.....	650	I. S. P..	24″	
*Mission st.....	Whittier st.....	Naglee ave.....	800	Brick...	2′ x3′	
*Lowell st.....	Brunswick st.....	Mission st.....	650	I. S. P..	12″	
*Naglee ave.....	Mission st.....	Huron ave.....	800	Brick...	2′6″x3′9″	
*Naglee ave	Huron ave.....	Wyoming ave.....	550	Brick...	3′ x4′6″	
*Foote ave.....	San Jose ave.....	the Railroad.....	400	I. S. P .	15″	
*Foote ave.....	the Railroad.....	Wyoming ave.....	400	I. S. P..	21″	
*Ocean ave.....	Howth st.....	Tara st.	600	I. S. P..	18″	
*Ocean ave.....	Tara st.....	San Jose ave.....	800	I. S. P..	21″	
*Ocean ave and Onondaga ave....	San Jose ave..	Cayuga ave.....	1570	Brick...	2′ x3′	
*San Jose ave.....	Unadilla ave.....	Ocean ave.....	1450	I. S. P..	18″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.
† Not recommended for immediate construction.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
COUNTY LINE EAST SUB-DISTRICT.						
*Guttenberg st.	Bellevue st.	Brunswick st.	950	I. S. P.	18″	
*Guttenberg st. and Watt ave, &c.	Brunswick st.	Mission st.	930	I. S. P.	21″	
*Mission st.	Foote ave.	Mt. Vernon ave.	1030	I. S. P.	24″	
*Mission st.	Mt. Vernon ave.	Amazon st.	1120	Brick.	2′ x3′	
*Morse st., produced	Curtis st.	Northeasterly.	850	I. S. P.	18″	
*Morse st., produced	last defined point.	Northeasterly.	900	I. S. P.	21″	
*Proposed new stre't	Bellevue ave, pro'c'd	Morse st., produced.	1200	Brick.	2′ x3′	
*Amazon st.	Morse st., produced.	Mission st.	2050	Brick.	2′6″x3′9″	
PERSIA AVENUE SUB-DISTRICT.						
*Persia ave.	Dublin st.	Athens st.	1060	I. S. P.	24″	
*Persia ave.	Athens st.	Edinburgh st.	800	Brick.	2′ x3′	
*Persia ave.	Edinburgh st.	Mission st.	1350	Brick.	2′6″x3′9″	
*Mission st.	Persia ave.	Onondaga ave.	780	Brick.	3′6″x5′3″	
*Mission st.	Amazon st.	France ave.	1200	Brick.	3′ x4′6″	
*Mission st.	France ave.	Onondaga ave.	500	Brick.	4′6″	
*Onondaga ave.	Mission st.	Cayuga ave.	700	Brick.	5′	
SILVER AVENUE WEST SUB-DISTRICT.						
*China ave.	Edinburgh st.	Mission st.	1350	I. S. P.	18″	
*Mission st.	China ave.	Silver ave.	1150	I. S. P.	24″	
*Mission st.	Silver ave.	Canal st.	1350	Brick.	2′6″x3′9″	
*Silver ave.	Vienna st.	Mission st.	2050	I. S. P.	24″	

LOWER ISLAIS CREEK SUB-DISTRICT.

SEWERS FOR SEWAGE PROPER, AND FOR SEWAGE AND RAIN-WATER.‖

	Length, Feet.	Material.	REMARKS.
Aggregate length of 10″ sewers.	560	I. S. P.	Recommended for immediate construction
Aggregate length of 12″ sewers.	1,440	I. S. P.	Recommended for immediate construction
Aggregate length of 15″ sewers.	1,320	I. S. P.	Recommended for immediate construction
Aggregate length of 18″ sewers.	4,670	I. S. P.	Recommended for immediate construction
Aggregate length of 24″ sewers.	2,520	I. S. P.	Recommended for immediate construction
Aggregate length of 7′6″ sewers.	1,130	Brick.	Recommended for immediate construction
Aggregate length of 3′x4′6″ sewers.	920	Brick.	Recommended for immediate construction

* Recommended for immediate construction. ‡ Existing sewer to remain in use.

† Not recommended for immediate construction. ‖ See Plate No. 7.

Character and Dimensions of Required Sewers.

Storm-Water Sewers‖.

Name of Street.	From	To	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
†Propos'd new street	Main sewer.....	Easterly.....	1480	Brick..	8′6″	
†Propos'd new street	last defined point...	Channel st.....	780	Brick...	8′ x10′	
†Channel st. and Barneveld ave....	last defined point...	San Bruno ave.....	1550	Brick...	12′ x10′	
†Barneveld ave.....	San Bruno ave.....	Northeasterly.....	1800	Brick...	14′ x10′	
†Barneveld ave.....	last defined point...	Islais creek.....	1800	Brick...	16′ x10′	

Mission Flats Sub-District.

Storm-Water Sewers‖.

‡Division st. (relief).	Eighteenth st.....	Seventeenth st.....	....	Brick...	11′ x9′	10′9″x5′9″
‡Division st.....	Seventeenth st.....	Eldorado st.....	....	Brick. .	11′ x9′	10′9″x5′9″
‡Division st	Eldorado st.....	Alameda st.....	...	Brick...	13′ x9′	10′9″x5′9″
‡Division st.....	Alameda st.	Tenth st.....	....	Brick...	13′ x9′	11′9″x8′9″
‡Division st.....	Tenth st.....	Ninth st.....	....	Brick...	20′ x9′	11′9″x8′9″
*Division, Berry and Ninth sts.....	Ninth st.....	Channel st.....	....	Brick...	20′ x9′	
*Harrison st. (relief)	Fifteenth st.....	Alameda st.....	350	Brick...	6′	
*Alameda st.....	Harrison st.....	Division st.....	240	Brick...	6′	
*Harrison st. (relief)	Eleventh st.....	Tenth st.....	500	Brick...	8′	
*Tenth st.....	Harrison st.....	Division st.....	1300	Brick...	8′	
*Seventh st.....	Howard st.....	Folsom st.....	635	Brick...	3′6″x5′3″	3′ x5′
*Seventh st..... ...	Folsom st.....	Brannan st.....	1910	Brick..	5′	3′ x5′
*Seventh st.....	Brannan st..	Berry st.....	1225	Brick...	5′6″	3′ x5′
*Sixth st.....	Howard st.....	Folsom st.....	635	Brick...	3′6″x5′3″	3′ x5′
*Sixth st.....	Folsom st.....	Brannan st.....	1910	Brick...	5′	3′ x5′
*Sixth st.....	Brannan st.....	Channel st.....	1610	Brick...	5′6″	3′ x5′
*Fifth st.....	Howard st.	Folsom st.....	635	Brick...	5′	3′ x5′
*Fifth st.....	Folsom st.....	Brannan st.....	1910	Brick...	7′6″x5′	3′ x5′
*Fifth st	Brannan st.....	Channel st.....	1610	Brick...	7′6″x5′	3′ x5′
**Fourth st.....	Howard st.....	Folsom st	635	I. S. P..	12″	3′ x5′
**Fourth st.....	Folsom st.....	Harrison st.....	636	I. S. P..	24″	3′ x5′
**Fourth st.....	Harrison st....	Bryant st.....	635	Brick...	3′ x4′6″	3′ x5′
**Fourth st.....	Bryant st.....	Brannan st.....	635	Brick...	4′	3′ x5′
*Fourth st.¶.....	Brannan st.....	Channel st.....	1610	Brick...	6′6″	3′ x5′

* Recommended for immediate construction. ‡ Existing sewer to remain in use.

† Not recommended for immediate construction.

‖ For location of storm-water sewers, see Plate No. 6. ¶ Berry to Channel, old sewer wood.

** Repair old sewer.

Character and Dimensions of Required Sewers.

MISSION FLATS SUB-DISTRICT—Continued.

Sewers for Sewage Proper, as Shown on Plate No. 7.

	Length, Feet.	Material.	Remarks.
Aggregate length of 8″ sewers	70,720	I. S. P.	Recommended for immediate construction
Aggregate length of 10″ sewers	46,210	I. S. P.	Recommended for immediate construction
Aggregate length of 12″ sewers	4,780	I. S. P.	Recommended for immediate construction
Aggregate length of 15″ sewers	2,640	I. S. P.	Recommended for immediate construction
Aggregate length of 18″ sewers	3,130	I. S. P.	Recommended for immediate construction
Aggregate length of 21″ sewers	4,380	I. S. P.	Recommended for immediate construction
Aggregate length of 30″ sewers	780	I. S. P.	Recommended for immediate construction
Aggregate length of 15″ iron pipe	200	I. S. P.	Recommended for immediate construction
Total	132,840		

YERBA BUENA DISTRICT.

Name of Street.	From	To	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
		Storm-Water Sewers.**				
*Jackson st.	Montgomery st.	East st.	2200	Brick...	6′	3′ x5′
*East st.	Jackson st.	Washington st.	400	Brick...	6′	4′ x5′‖
§Howard st.	Second st.	East st.	2800	.....	.....	3′ x5′
*Mission st.	New Montgomery st.	First st.	1200	Brick...	3′ x4′6″	3′ x5′††
§Mission st.	First st.	East st.	2200	.....	.....	3′ x5′
§Sutter st.	Montgomery st.	Market st.	550	.....	.....	3′ x5′
§Bush st.	Montgomery st.	Market st.	1000	.....	.....	3′ x5′
§California st.	Montgomery st.	Market st.	1900	.....	.....	3′ x5′
§Commercial st.	Montgomery st.	East st.	2500	.....	.....	3′ x5′
§Market st.	Bush st.	East st.	1850	.....	.....	3′ x5′
§East st.	Market st.	Washington st.	650	.....	.....	3′ x5′‖

* Recommended for immediate construction. § Repair old sewer. ‖ Wood.
** For location of storm-water sewers, see Plate No. 6. †† Too high.

Sewers for Sewage Proper, as Shown on Plate No. 7.

	Length, Feet.	Material.	Remarks.
Aggregate length of 8″ sewer	33,780	I. S. P.	Recommended for immediate construction
Aggregate length of 10″ sewer	34,240	I. S. P.	Recommended for immediate construction
Aggregate length of 12″ sewer	1,240	I. S. P.	Recommended for immediate construction
Aggregate length of 15″ sewer	2,650	I. S. P.	Recommended for immediate construction
Aggregate length of 18″ sewer	450	I. S. P.	Recommended for immediate construction
Aggregate length of 21″ sewer	400	I. S. P.	Recommended for immediate construction
Total	72,760		

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
HUNTER'S POINT DISTRICT.						
MAIN SEWER. **						
†Canal, Congdon, Trumbull and proposed new streets.	Mission st.....	Harvard st., prod'c'd	2180	Brick...	7′6″	
†Propos'd new street	Harvard st., prod'c'd	Relief outlet.....	1300	Brick...	8′	
†Propos'd new street	Relief outlet.....	Southeasterly	920	I. S. P..	18″	
†Propos'd new street	Last defined point. .	Northeasterly.....	730	I. S. P..	24″	
†Propos'd new street	Last defined point ..	Boylston st.....	800	Brick...	2′ x3′	
*Sweeny st.....	Boylston st.....	Barneveld ave.....	1020	Brick...	3′ x4′6″	
*Barneveld ave and Gaven st.....	Sweeny st.....	San Bruno ave.....	530	Brick...	3′ x4′6″	
*Steuben and Augusta sts.....	San Bruno ave.....	Charter Oak ave.....	630	Brick...	3′ x4′6″	
*Charter Oak ave....	Augusta st.....	Helena st.....	750	Brick...	3′ x4′6″	
*Helena and S sts. & Seventeenth ave	Charter Oak ave....	R st.-17th ave.....	2164	Brick...	3′ x4′6″	
*R st.-Fifteenth ave.	Seventeenth ave....	Q st	1230	Brick...	3′6″x5′3″	
*Q st. and Fourteenth ave.	Fifteenth ave.....	P st.-14th ave.....	744	Brick...	5′	
*P st. and Tenth ave	Fourteenth ave.	Railroad ave.....	1770	Brick...	5′6″	
*N st.....	Railroad ave.....	Seventh ave.....	840	Brick...	6′	
*Seventh ave, M st., Sixth ave, L st. and Fifth ave.....	N st.....	K st.....	2550	Brick...	6′6″	
*Fifth ave.....	K st.....	J st.....	664	Brick...	7′	
*Fifth ave.....	J st	H st.....	1320	Brick...	7′6″	
*H st.....	Fifth ave.....	Sixth ave.....	280	Brick...	3′ x4′6″	
†Sixth ave.....	H st.....	F st.....	1320	Brick...	3′ x4′6″	
†Sixth ave.....	F st.....	C st.....	1980	Brick...	5′6″	
†Sixth ave.....	C st.....	A st.....	1330	Brick...	6′	
†A st.....	Sixth ave.....	Fifth ave.....	280	Brick...	6′6″	
†Easterly.....	Fifth ave and A st..	Hunter's Point.....	1200	Brick...	6′6″	
Outfall pipe.....	.....	.....	500	C. Iron.	48″	
*San Bruno ave.....	Gaven st.....	Islais Creek.....	500	Brick...	5′6″	
COLLEGE HOMESTEAD SUB-DISTRICT.						
†Silliman st.....	Madison st.....	Harvard st.	610	I. S. P..	15″	
†Harvard st. and same produced....	Silliman st.....	Main st.....	1350	I. S. P..	18″	
SOUTH BERNAL HEIGHTS SUB-DISTRICT.						
*Folsom st.....	Powhattan st.....	Jefferson ave.	1170	I. S. P..	18″	
*Jefferson ave.....	Ellsworth st.....	Folsom st.....	360	I. S. P..	18″	
*Jefferson ave.....	Folsom st.....	Prentiss st.....	360	I. S. P..	21″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use

† Not recommended for immediate construction.

**All lettered and numbered streets on this page are 'South.'

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
SOUTH BERNAL HEIGHTS SUB-DISTRICT—CONTINUED.						
*Prentiss st.	Jefferson ave.	Crescent ave.	1300	I. S. P..	21″	
*Andover ave.	East ave.	Crescent ave.	790	I. S. P..	21″	
*Crescent ave.	Andover ave.	Prentiss st.	1260	I. S. P..	24″	
*Prentiss st. and proposed new street..	Crescent ave.	Sweeny st.	1130	Cast-ir'n	12″	
*Prentiss and proposed new street..	Crescent ave.	.....	800	Brick...	5′	
UNIVERSITY MOUND SUB-DISTRICT.						
†Wayland st.	Mansfield st.	Madison st.	600	I. S. P..	12″	
†Wayland st.	Madison st.	Gambier st.	300	I. S. P..	15″	
†Wayland st.	Gambier st.	Oxford st.	600	I. S. P..	18″	
†Wayland st.	Oxford st.	Yale st.	600	I. S. P..	21″	
†Wayland st.	Yale st.	Holyoke st.	2400	Brick...	2′ x3′	
†Wayland st..	Holyoke st.	Goettingen st.	600	Brick ..	3′ x4′6″	
*Goettingen st.	Wayland st.	Bacon st.	460	Brick...	5′6″	
*Bacon st.	Goettingen st.	Berlin st.	300	Brick...	5′6″	
*Berlin st.	Bacon st.	Burrows st.	460	Brick...	5′6″	
*Burrows st.	Berlin st.	Girard st	300	Brick...	5′6″	
*Girard st.	Burrows st.	Felton st.	460	Brick...	5′6″	
*Felton st.	Girard st.	San Bruno ave.	300	Brick...	5′6″	
*San Bruno ave.	Felton st.	Silliman st.	460	Brick...	5′6″	
*San Bruno ave.	Silliman st.	Silver ave.	460	Brick...	3′6″x5′3″	
*San Bruno ave.	Silver ave.	Gaven st.	600	Brick...	3′ x4′6″	
†Dwight st.	Mansfield st.	Gambier st.	900	I. S. P..	12″	
†Dwight st.	Gambier st.	Oxford st.	600	I. S. P..	15″	
†Oxford st.	Dwight st.	Woolsey st.	460	I. S. P..	18″	
†Woolsey st.	Oxford st.	Yale st.	600	I. S. P..	18″	
†Woolsey st.	Yale st.	Princeton st.	600	I. S. P..	21″	
†Woolsey st.	Princeton st.	College st.	600	I. S. P..	24″	
†Woolsey st.	College st.	Bowdoin st.	600	Brick...	2′ x3′	
†Woolsey st.	Bowdoin st.	Holyoke st.	600	Brick...	2′6″x3′9″	
†Holyoke st.	Woolsey st.	Wayland st.	460	Brick...	2′6″x3′9″	
†Silver ave.	Yale st.	Princeton st.	700	I. S. P..	15″	
†Princeton st.	Silver ave.	Felton st.	600	I. S. P..	18″	
†Felton st.	Gambier st.	Amherst st.	600	I. S. P..	12″	
†Felton st.	Amherst st.	Princeton st.	300	I. S. P..	18″	
†Felton st.	Princeton st.	College st.	600	I. S. P..	21″	
†Felton st.	College st.	Bowdoin st.	600	I. S. P..	24″	
†Felton st.	Bowdoin st.	Girard st.	1800	Brick...	2′ x3′	
†Silver ave.	Holyoke st.	Somerset st.	300	I. S. P..	18″	
†Silver ave.	Somerset st	Berlin st.	600	I. S. P..	21′	
†Silver ave.	Berlin st.	San Bruno ave.	600	I. S. P..	24″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.
† Not recommended for immediate construction.

Character and Dimensions of Required Sewers.

Name of Street.	From	To	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
NORTH SILVER HEIGHTS SUB-DISTRICT.						
*Q st. South	17th ave South	15th ave South	560	I. S. P.	18″	
RAILROAD AVENUE SUB-DISTRICT.						
*Railroad ave	16th ave. South	13th ave. South	900	I. S. P.	24″	
*Railroad ave	13th ave. South	10th ave. South	900	Brick	2′6″x3′9″	
SOUTH SLOPE OF HUNTER'S POINT SUB DISTRICT.						
*J st. South	20th ave. South	19th ave. South	290	I. S. P.	24″	
*19th ave. South	J st. South	H st. South	1325	Brick	2′ x3′	
*H st. South	19th ave. South	17th ave	560	Brick	3′ x4′6″	
*17th ave. South	H st. South	G st. South	662	Brick	3′6″x5′3″	
*G st. South	17th av. South	15th ave. South	560	Brick	3′6″x5′3″	
*15th ave. South	G st. South	F st. South	662	Brick	4′6″	
*F st. South	15th ave. South	9th ave. South	1675	Tunnel	3′ x4′6″	
†F st. South	9th ave. South	6th ave. South	840	Brick	2′ x3′	
BAY VIEW SUB-DISTRICT **Storm-Water Sewers.**						
†Olmstead st	Holyoke st.	Somerset st	300	I. S. P.	18″	
†Olmstead st	Somerset st	Berlin st	600	I. S. P.	21″	
†Olmstead st	Berlin st.	San Bruno ave	600	I. S. P.	24″	
†San Bruno ave	Olmstead st.	Wayland st.	1380	Brick	2′ x3′	
†Wayland st	San Bruno av	Charter Oak ave	300	Brick	2′6″x3′9″	
†Charter Oak ave	Wayland st.	P st. South	350	Brick	2′6″x3′9″	
†P st. South	Charter Oak ave	28th ave. South	530	Brick	2′6″x3′9″	
†28th ave. South	P st. South	M st. South	1325	Brick	3′6″x5′3″	
†M st. South	28th ave. South	27th ave. South	280	Brick	3′6″x5′3″	
†27th ave. South	M st. South	L st. South	6625	Brick	3′6″x5′3″	
†L st. South	27th ave. South	26th ave. South	280	Brick	3′6″x5′3″	
†26th ave. South	L st. South	K st. South	6625	Brick	4′6″	
†26th ave. South	K st. South	I st. South	1325	Brick	5′6″	
†I st. South	26th ave. South	24th ave. South	560	Brick	6′	
†Harkness st	Goettingen st.	San Bruno ave	700	I. S. P.	15″	
†K st. South	San Bruno ave	36th ave. South	800	I. S. P.	18″	
†K st. South	36th ave. South	Salinas ave.	650	Brick	2′ x3′	
†Salinas ave	K st. South	Railroad ave	200	Brick	2′6″x3′9″	
†Railroad ave	Salinas ave.	31st ave. South	665	Brick	2′6″x3′9″	
†K st. South	31st ave. South	28th ave. South	840	Brick	2′6″x3′9″	
†K st. South	28th ave. South	26th ave. South	560	Brick	3′ x4′6″	
†K st. South	26th ave. South	25th ave. South	280	I. S. P.	12″	
†J st. South	38th ave. South	36th ave. South	560	I. S. P.	18″	
†J st. South	36th ave. South	34th ave. South	560	I. S. P.	21″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.
† Not recommended for immediate construction.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of old Sewer.
BAY VIEW SUB-DISTRICT—STORM-WATER SEWERS, CONTINUED.						
†J st. South	34th ave. South	32d ave. South	560	I. S. P.	24″	
†J st. South	32d ave. South	26th ave. South	1680	Brick	2′6″x3′9″	
†J st. South	26th ave. South	25th ave. South	280	I. S. P.	12″	
†I st. South	31st ave. South	30th ave. South	280	I. S. P.	12″	
†I st. South	30th ave. South	28th ave. South	560	I. S. P.	18″	
†I st. South	28th ave. South	26th ave. South	560	I. S. P.	24″	
†Goettingen st	Mansell st	Olmstead st	460	I. S. P.	12″	
†Berlin st	Mansell st	Olmstead st	460	I. S. P.	12″	
†Girard st	Mansell st	Olmstead st	460	I. S. P.	12″	
†San Bruno ave	Mansell st	Olmstead st	460	I. S. P.	12″	
†Wayland st	Berlin st	San Bruno ave	600	I. S. P.	18″	
†Bacon st	San Bruno ave	Charter Oak ave	300	I. S. P.	15″	
†Charter Oak ave	P st. South	Burrows st	600	I. S. P.	15″	
†27th ave. South	P st. South	M st. South	1325	I. S. P.	24″	
†26th ave. South	P st. South	N st. South	6625	I. S. P.	21″	
†26th ave. South	N st. South	M st. South	6625	I. S. P.	24″	
†26th ave. South	M st. South	L st. South	6625	Brick	2′ x3′	
†N st. South	26th ave. South	Williams ave	500	I. S. P.	18″	
†Williams ave	Venus st	Diana st	520	I. S. P.	12″	
†M st. South	26th ave. South	Williams ave	800	I. S. P.	18″	
†Williams ave	Jupiter st	Lucy st	520	I. S. P.	12″	
†Railroad ave	26th ave. South	24th ave. South	600	I. S. P.	21″	
†Railroad ave	24th ave. South	22d ave. South	530	I. S. P.	18″	
†23d ave. South	K st. South	J st. South	6625	I. S. P.	24″	
†23d ave. South	J st. South	I st. South	6625	Brick	2′ x3′	
†23d ave. South	I st. South	Point 100 ft. S. E.	100	Brick	2′6″x3′9″	
†K st. South	24th ave. South	28d ave. South	280	I. S. P.	12″	
†K st. South	23d ave. South	22d ave. South	280	I. S. P.	15″	
†K st. South	22d ave. South	21st ave. South	280	I. S. P.	12″	
†J st. South	24th ave. South	23d ave. South	280	I. S. P.	12″	
†J st. South	23d ave. South	22d ave. South	280	I. S. P.	15″	
†J st. South	22d ave. South	21st ave. South	28	I. S. P.	12″	
†I st. South	23d ave. South	21st ave. South	560	I. S. P.	12″	
†I st. South	21st ave. South	20th ave. South	280	I. S. P.	12″	
SEWERS FOR SEWAGE PROPER.						
†Olmstead st	Holyoke st	San Bruno ave	1500	I. S. P.	10″	
*San Bruno ave	Olmstead st	Wayland st	1380	I. S. P.	10″	
*Wayland st	San Bruno ave	Charter Oak ave	300	I. S. P.	10″	
*Charter Oak ave	Wayland st	P st. South	330	I. S. P.	10″	
*P st. South	Charter Oak ave	28th ave. South	500	I. S. P.	10″	
*28th ave. South	P st. South	M st. South	1325	I. S. P.	12″	
*M st. South	28th ave. South	27th ave. South	280	I. S. P.	12″	
*27th ave. South	M st. South	L st. South	662	I. S. P.	15″	
*L st. South	27th ave. South	26th ave South	280	I. S. P.	15″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.
† Not recommended for immediate construction.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
BAY VIEW SUB-DISTRICT—SEWERS FOR SEWAGE PROPER, CONSIDERED.						
*26th ave. South....	L st. South.....	Railroad ave.....	250	L. S. P..	15″	
*28th ave. South....	Railroad ave.....	Pump.....	1000	L. S. P..	18″	
†K st. South.....	San Bruno ave.....	Salinas ave.	1400	L. S. P..	10″	
†Salinas ave.....	K st. South.....	Railroad ave.....	2?0	L. S. P..	12″	
*Railroad ave.....	Salinas ave.	29th ave. South.....	1250	L. S. P..	12″	
*Railroad ave.....	29th ave. South.....	28th ave. South....	900	L. S. P..	15″	
*Railroad ave.....	24th ave. South.....	26th ave. South.....	580	L. S. P..	10″	
†J st. South.....	33d ave. South.....	28th ave. South.....	1400	L. S. P..	10″	
†J st. South.....	28th ave. South. ...	26th ave. South.....	560	L. S. P.	12″	
†26th ave. South....	J st. South....	Pump.....	100	L. S. P..	12″	
†J st. South.....	21st ave. South.....	24th ave. South.....	840	L. S. P..	10″	
†J st. South.....	24th ave. South.....	Pump	500	L. S. P..	12″	
HARBOR VIEW DISTRICT.						
‡Broadway st.....	Leavenworth st.....	Hyde st.....	480	I. S. P..	21″	3′ x5′
‡Broadway st.....	Hyde st.....	Larkin st.....	480	Brick...	2′ x3′	3′ x5′
‡Broadway st.....	Larkin st.....	Polk st.....	480	Brick...	2′6″ x3′9″	3′ x5′
‡Polk st.....	Broadway st.....	Vallejo st.....	345	Brick...	3′ x4′6″	3′ x5′
‡Vallejo st.....	Polk st.....	Franklin st.....	960	Brick...	3′ x4′6″	3′ x5′
‡Franklin st.....	Vallejo st.....	Union st.....	690	Brick...	3′ x4′6″	3′ x5′
‡Franklin st.....	Union st.....	Lombard st.....	1035	Brick...	3′6″x5′3″	3′ x5′
‡Lombard st.....	Franklin st.....	Octavia st.....	960	Brick...	3′6″x5′3″	3′ x5′
‡Lombard st.....	Octavia st.....	Laguna st.....	480	Brick...	4′6″	3′ x5′
‡‡Lombard st.....	Laguna st.....	Buchanan st.....	480	I. S. P..	15″	3′ x5′
‡Lombard st.... ...	Buchanan st	Fillmore st.....	960	Brick...	2′6″x3′9″	3′ x5′
‡Fillmore st..... .	Lombard st.....	Francisco st.....	690	Brick...	3′ x4′6″	3′ x5′
*Francisco st.....	Fillmore st.....	Steiner st.....	480	I. S. P..	18″	
*Francisco st.....	Steiner st.....	Pierce st.....	480	I. S. P..	21″	
*Francisco st.....	Pierce st.....	Scott st.....	480	Brick...	3′6″x5′3″	
*Gough st.	Filbert st.....	Greenwich st.....	345	Brick...	2′ x3′	18″
*Greenwich st.....	Gough st.....	Octavia st.....	480	Brick...	2′6″x3′9″	12″
‡Octavia st.....	Greenwich st...	Lombard st.....	345	Brick...	2′6″x3′9″	4
‡Laguna st.....	Green st..... ...	Filbert st.....	690	I. S. P..	21″	3′ x5′
‡Laguna st.....	Filbert st.....	Lombard st.....	690	Brick...	2′6″x3′9″	3′ x5′
‡Buchanan st.	Union st.....	Greenwich st.....	690	I. S. P..	24″	18″
‡Buchanan st.....	Greenwich st.	Lombard st.....	345	Brick...	2′ x3′	18″
‡Fillmore st.....	Union st.....	Filbert st.....	345	I. S. P..	21″	18″
‡Fillmore st.....	Filbert st.....	Lombard st..... ...	690	Brick...	2′ x3′	18″
‖Laguna st.....	Lombard st.....	Tonquin st.	2415	Brick...	4′6″	20″
†Tonquin st.....	Laguna st.....	Webster st.....	960	I. S. P..	24″	
†Webster st.....	Tonquin st.	Lewis st.....	345	I. S P..	24″	
‡Lewis st.....	Webster st.....	Scott st.....	1920	I. S. P..	24″	
**Fillmore st.....	Francisco st..... ..	Lewis st.....	2070	Brick...	4′6″	3′ x5′
*Francisco st.....	Laguna st.....	Fillmore st.....	1440	Brick ..	3′ x4′6″	
*Laguna st.....	Chestnut st..... ..	Bay st.....	690	Brick...	2′ x3′	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.

† Not recommended for immediate construction.

‖ Bay to Beach; 1,800′ from Lombard to Beach st.; immediate construction.

** Francisco to Bay; existing sewer to be used to Bay st.; balance not recommended.

‡‡ Existing sewer to remain in use, reduced.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
HARBOR VIEW DISTRICT—CONTINUED.						
‡Bay st	Laguna st	Octavia st	480	Brick	2′ x3′	16″
‡Bay st	Octavia st	Van Ness ave.	1440	I. S. P.	24″	16″
*Chestnut st	Laguna st	Gough st	960	Brick	2′ x3′	
*Chestnut st	Gough st	Franklin st.	480	I. S. P.	24″	
‡Chestnut st	Franklin st	Van Ness ave.	480	I. S. P.	24″	12″
*Union st	Lyon st	Baker st	480	I. S. P.	24″	12″
*Baker st	Union st	Filbert st	345	Brick	2′ x3′	16″ 16″
*Baker st	Filbert st	Chestnut st	1035	Brick	2′6″x3′9″	14″x16″ 18″
*Chestnut st	Baker st	Broderick st	480	Brick	8′ x4′6″	
*Chestnut st	Broderick st	Devisadero st	480	I. S. P.	15″	
*Chestnut st	Devisadero st	Scott st.	480	I. S. P.	21″	
*Scott st	Chestnut st	Francisco st.	345	Brick	2′6″x3′9″	
*Scott st	Francisco st	Lewis st	2070	Brick	5′	
Outfall	Lewis st	deep water	800	Iron	36″	
*Scott st	Filbert st	Greenwich st.	345	I. S. P.	21″	
*Scott st	Greenwich st	Lombard st.	345	I. S. P.	24″	
*Scott st	Lombard st	Chestnut st.	345	Brick	2′6″x3′9″	
*Broderick st	Chestnut st	Lewis st	2415	Brick	4′6″	
†Tonquin st	Broderick st	Scott st.	960	I. S. P.	24″	18″
‡Steiner st	Union st	Filbert st.	345	I. S. P.	21″	18″
‡Steiner st	Filbert st	Greenwich st.	345	Brick	2′ x3′	16″
*Steiner st	Greenwich st	Chestnut st.	690	Brick	2′ x3′	18″
*Chestnut st	Steiner st	Pierce st.	480	Brick	2′ x3′	18″
‡Pierce st	Greenwich st	Lombard st.	345	I. S. P.	24″	16″
‡Pierce st	Lombard st	Chestnut st.	345	Brick	2′ x3′	8′ x5′
‡Pierce st	Chestnut st	Francisco st.	345	Brick	3′ x4′6″	
*Broderick st	Lombard st	Chestnut st	345	I. S. P.	24″	
RICHMOND DISTRICT.						
*Twenty-seventh ave	Fulton st.	C st	680	Brick	2′ x3′	
*C st	Twenty-seventh ave.	Twenty-fifth st.	620	Brick	2′ x3′	
*C st	Twenty-fifth ave.	Twenty-third st.	620	Brick	3′ x4′6″	
*Twenty-third ave.	C st.	A st.	1360	Brick	3′ x4′6″	
*Twenty-third ave.	A st.	Point Lobos ave.	700	Brick	3′6″x5′3″	
*A st	Thirteenth ave.	Fourteenth st.	370	Brick	2′ x3′	
*Fourteenth ave.	A st.	Point Lobos ave.	750	Brick	2′6″x3′9″	
Outfall			800	Iron	36″	
WEST RICHMOND DISTRICT. STORM-WATER SEWERS.						
†Fulton st	Thirty-second ave.	Thirty-third ave.	310	I. S. P.	24″	
†Fulton st	Thirty-third ave.	Forty-third ave.	3100	Brick	2′6″x3′9″	
†Fulton st	Forty-third ave.	Forty-ninth ave.	1860	Brick	3′ x4′6″	
†Fu'ton st	Forty-ninth ave.	Out-fall	500	Brick	3′6″x5′3″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.
† Not recommended for immediate construction.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Size of Old Sewer.
WEST RICHMOND DISTRICT—STORM-WATER SEWERS, CONTINUED.						
†C st.	Thirty-seventh ave.	Thirty-ninth ave.	620	Brick.	2′ x3′	
†C st.	Thirty-ninth ave.	Fo ty-second ave.	930	Brick.	2′6″x3′9″	
†Forty-second ave.	C st.	Fulton st.	685	Brick.	2′6″x3′9″	
†B st.	Fortieth ave.	Forty-first ave.	310	I. S. P.	24″	
†B st.	Forty-first ave.	Forty-fifth ave.	1240	Brick.	2′ x3′	
†B st.	Forty-fifth ave.	Forty-ninth ave.	1240	Brick.	2′6″x3′9″	
†B st.	Forty-ninth ave.	Out fall.	1800	Brick.	3′6″x5′3″	
SEWERS FOR SEWAGE PROPER.						
*Fulton st.	Twenty-eighth ave.	Forty-third ave.	4650	I. S. P.	10″	
*Fulton st.	Forty-third ave.	Pump station.	1900	I. S. P.	12″	
UPPER AND LOWER SUNSET DISTRICTS.						
SEWERS FOR STORM-WATER.						
*H st.	Seventh ave.	Tenth ave.	930	Brick.	4′6″	
‡H st.	Tenth ave.	Fourteenth ave.	1240	Brick.	6′	
*H st.	Fourteenth ave.	Great Highway.	11000	Brick.	6′	
*Great Highway.	H st.	J st.	1360	Brick.	7′	
*J st.	Great Highway.	Outfall.	300	Brick.		
*Seventh ave.	N st	H st.	4080	Brick.	3′ x4′6″	
‡J st	Ninth ave	Tenth ave.	310	Brick.	2′ x3′	
‡Tenth ave.	J st.	Towards I st.	340	Brick.	2′ x3′	2′6″
‡Tenth ave.	Towards	I st.	340	Brick.	2′6″x3′9″	2′8″
‡Tenth ave.	I st.	H st.	680	Brick.	2′6″x3′9″	2′6″x3′9″
*Tenth ave.	N st.	M st	680	I. S P.	18″	13″
*Tenth ave.	M st.	L st	680	I. S. P.	21″	12″
*Tenth ave.	L st.	K st.	680	I. S. P.	24″	
*K st.	Tenth ave.	Eleventh ave.	310	Brick.	2′ x3′	
*K st.	Eleventh ave.	Twelfth ave.	310	Brick.	2′6″x3′9″	
*Twelfth ave.	K st.	Towards	1020	Brick.	2′6″x3′9″	
*Twelfth ave.	Towards	J st.	340	Brick.	3′ x4′6″	8″
*I st.	Twelfth ave.	Thirteenth ave.	310	Brick.	3′ x4′6″	
*I st.	Thirteenth ave.	Fourteenth ave.	310	Brick.	3′6″x5′3″	
*Fourteenth ave.	I st.	H st.	680	Brick.	3′6″x5′3″	
UPPER SUNSET DISTRICT.						
SEWERS FOR SEWAGE PROPER.						
*Seventh ave.	N st	H st.	4080	I. S. P.	11″	
*H st.	Seventh ave.	Tenth ave.	930	I. S. P.	12″	
*H st.	Tenth ave.	Eleventh ave.	310	I. S. P.	15″	
*H st.	Eleventh ave.	Fifteenth ave.	1240	I. S. P.	18″	
*H st	Fifteenth ave.	Thirtieth ave.	4650	I. S. P.	21″	
*Across Park.	H st.	Fulton st.	3200	Cast I.	16″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.
† Not recommended for immediate construction.

CHARACTER AND DIMENSIONS OF REQUIRED SEWERS.

NAME OF STREET.	FROM	TO	Length, Feet.	Material.	Prescribed Size.	Side of Old Sewer.
LOWER SUNSET DISTRICT. SEWERS FOR SEWAGE PROPER.						
*Great Highway....	X st.....	N st.....	6800	I. S. P..	24″	
*Great Highway....	N st.....	Fulton st.....	6800	I. S. P..	30″	
*Fulton st.....	Great Highway....	Forty-ninth ave.....	250	I. S. P..	30″	
*Forty-ninth ave ...	Fulton st.....	Pump	175	I. S. P..	30″	
OCEAN VIEW DISTRICT. SEWERS FOR SEWAGE PROPER.						
*Orizaba st....	Lobos st.....	De Long st.....	1900	I. S. P..	10″	
*Stanley st.....	Orizaba st.....	Vernon st.....	1550	I. S. P..	10″	
*Main outfall.....	Stanley & Vernon sts	Holloway extended.	4200	I. S. P..	12″	
*Main outfall.....	Holloway extended.	1600 ft. Northerly...	1600	I. pipe‖.	15″	
*Main outfall.....	1600 ft. Northerly...	2600 ft. Northerly...	1000	I. S. P..	18″	
*Main outfall.....	2600 ft. Northerly...	3000 ft. Northerly...	400	I. pipe‖.	18″	
*Main outfall.....	3000 ft. Northerly ..	Ocean ave.....	1200	I. S. P..	21″	
*Ocean ave.....	Junction Ocean ave.	5400 ft. Westerly....	5400	I. S. P..	21″	
*Ocean ave.....	5400 ft. Westerly....	Great Highway.....	3500	I. pipe..	8″	
*Randolph st.....	Ralston st.....	Bixby st	250	I. S. P..	10″	
*Worcester ave.....	Randolph st.....	1300 ft. N. Westerly.	130	I. S. P..	10″	
*Branch Line.....	Worcester ave.....	Main outfall.....	350	I. S. P..	10″	
†Holloway ave extended.....	Orizaba st.....	Main outfall.....	3000	I. S. P..	10″	
*Ocean ave	Lee ave.....	1500 ft. West of Ingleside Inn.....	7400	I. S. P..	10″	
*In Ingleside Tract Grounds.....	Arlington ave.....	Main outfall.....	3000	I. S. P..	15″	
†Short Branch, 700 feet South of Inn.	Rancho Line.....	Main outfall.....	450	I. S. P..	10″	

* Recommended for immediate construction. ‡ Existing sewer to remain in use.

† Not recommended for immediate construction.

For location of main outfall and branches, see Plate No. 7. ‖ On trestle.

ESTIMATE OF COST.

The sewers and works recommended for construction and as described in this report, together with the work necessary to make efficient such of the existing sewers as have been incorporated into this system as mains or sub-mains of local districts are covered by the following estimate of cost:

North Point main sewer, from Islais Creek to 18th st., including 4,500 ft. of tunnel	$ 139,688
North Point main sewer, from 18th st. to outfall at North Point, including tunnel 2,500 ft. long, a screen-house and two 60-inch outfall pipes	645,150
North Point main relief outlets and special structures, manholes, flushing gates and connections with old sewers	46,800
Channel-street storm-water extension to 7th st.; 15th-st. storm-water sewer from North Point main to Channel st.; 11th-st. storm-water sewer from North Point main to Channel st	143,900
North Point District sub-mains and intercepting sewers as recommended for construction in the sub-districts tributary to the North Point main by gravity flow	930,518
North Point District manholes, relief outlets, repairing old sewers, cut-outs and special structures in the sub-districts tributary to the North Point main by gravity flow	86,199
Lower Islais Creek District sewers as recommended for construction	47,409
Lower Islais Creek District manholes, repairing old sewers, cut-outs and special structures	7,120
Lower Islais Creek District pumping station, including 4,700 ft. of 18-inch cast-iron pipe, but not including real estate	65,000
Mission Flats District sewers as recommended for construction, not including the storm-water sewers	220,364
Mission Flats District manholes and connections with house drains	24,075

Mission Flats District storm-water sewers, including the sewers on 5th, 6th and 7th sts. below Howard, and repairs to and reconstruction of old sewers...	$ 194,301
Mission Flats District pumping station, including 4,100 ft. of 18-inch cast-iron pipe, not including real estate	75,000
Yerba Buena District sewers as recommended for construction, not including storm-water sewers.....	169,405
Yerba Buena District sewers, manholes and connections with house drains.....	12,175
Yerba Buena District pumping station, including 2,100 ft. of 16-inch cast-iron pipe, not including real estate	65,000
Yerba Buena District storm-water sewers, including manholes, repairing old sewers, cut-outs, etc.....	58,940
Hunter's Point main sewer from Boylston st. to near H st. South as recommended for construction....	217,569
Hunter's Point District sub-mains and intercepters as recommended for construction, not including Bay View District sewers.....	115,373
Hunter's Point District manholes, relief outlets and two outfall pipes, not including manholes, etc., on the Bay View District sewers.....	25,460
Bay View District sewers for sewage proper as recommended for construction, including manholes, etc.	13,238
Bay View District pumping station, two receivers, including 1,650 ft. of 8-inch cast-iron pipe, not including real estate.....	41,500
Harbor View District sewers as recommended for construction, including 36-inch outfall pipe and screen chamber, manholes, cut-outs, repairing old sewers, etc	146,998
Richmond District and Upper Sunset District sewers as recommended for construction, including the sewers for sewage of Upper Sunset District and a 16-inch cast-iron pipe across Golden Gate Park; also including manholes and the extension of the outfall pipe of the Richmond main, but not including storm-water sewers.....	85,150

West Richmond District, Lower Sunset District and Ocean View District sewers for sewage proper as recommended for construction, including manholes, trestles, cast-iron pipe, etc	$ 120,320
West Richmond pumping station, two receivers, including 6,650 ft. of 8-inch cast-iron pipe, not including real estate	42,500
Upper Sunset District and Lower Sunset District storm-water sewers as recommended for immediate construction, including manholes, outfall structure, connections with the West Richmond main, etc	244,405
Total	$3,983,557
Add for engineering, contingent and incidental expenses	556,443
Total cost of works recommended	$4,540,000
Real estate, rights of way, opening of new streets and grade changes	60,000
Grand total	$4,600,000

This estimate of cost has not been restricted to the great main sewers, but all sub-mains have been included which are necessary to make the system complete and efficient, even when such sub-mains are small and serve but a few blocks. It has been the endeavor, too, to afford outlet facilities to every improved portion of the City, even where the area served is but sparsely populated and the cost to secure delivery of sewage to the point of disposal has been relatively great.

The extent to which the construction of sub-mains and works connected therewith has received consideration and has been covered by the cost estimate, is made plain by the above items of $930,518 and $86,199, which together cover the gravity sub-mains and their branches tributary to the North Point main sewer, and include an extension of the system throughout the whole of the sparsely settled Upper Islais Creek region.

It remains to be said that the estimate has been made liberal, with due consideration of uncertainty in the matter of price of materials and the unforseen difficulties of execution, which, by reason of the scant time available, could not be as thoroughly investigated as would otherwise have been done.

C. E. GRUNSKY,
Civil Engineer in Charge.
MARSDEN MANSON,
Associate Engineer.
C. S. TILTON,
Associate Engineer.

San Francisco, Oct. 21, 1899.

APPENDIX A.

SAN FRANCISCO, October 21, 1899.

To the Hon. James D. Phelan, Mayor, and the Board of Supervisors of the City and County of San Francisco—

GENTLEMEN: In accordance with your Resolution No. 2,964 (4th Series), adopted at a meeting held June 12th, 1899, requesting me to visit this City "for the purposes of examination of plans, consultation and final approval of the plans of the Board of Engineers" "charged with the laying out of a sewer system as provided for in Resolution No. 2,764," and in subsequent Resolution No. 3,386, I respectfully present to you the following report:

During the month of June a consultation was arranged by His Honor the Mayor, with the Engineers and myself, at which the work designated in the first mentioned Resolution was defined and at once begun.

It was first necessary to inform myself regarding the scope of the problem, and to acquaint myself with the previous work that had been done towards solving the same. Briefly stated, the problem related to devising a plan by which the sewage and rain water of the City and County of San Francisco could be removed and finally disposed of in such a manner that no nuisance would be caused by the sewage, and that the greatest possible economy would be observed in the rainwater removal. Several reports had been made on previous occasions pointing out the desirability of establishing an improved system of sewerage, describing the defects existing at present, and making suggestions for improvements. The most valuable contribution was the Progress Report of the Engineers in Charge to devise a System of Sewerage, in 1893, made by Mr. Marsden Manson and Mr. C. E. Grunsky, Civil Engineers.

In order to further prepare myself for the above mentioned duties, it was necessary to make a thorough examination of the territory of the County with reference to its topographic conditions and the extent of present and probable future improvements. It was also necessary to acquaint myself with the hydrography of the Bay and Ocean adjoining the City.

The Engineers accompanied me over the entire ground and furnished me with all the information they had collected up to

that time, as well as with their conclusions based upon it. During this visit the fundamental data, as well as the general principles governing the case under consideration, were fully discussed.

A second visit was made during the present month. A very thorough study had meantime been made by the Engineers, and a plan had been developed which solved the problem in its general features. Maps of the location of the principal sewers, profiles of their elevations and estimates of their cost of construction were being prepared. A full report was likewise in the course of preparation describing in detail the proposed works.

After a thorough examination of the entire subject as regards the physical conditions of the territory and requirements of the citizens on the one hand, and as regards the sewerage system proposed to satisfy them on the other hand, I now respectfully present my approval of the recommended solution of the problem and give my reasons therefor.

FINAL DISPOSITION OF THE RAINWATER AND SEWAGE.

There is no difficulty in finally disposing of the City's rainwater. Where it falls upon built-up and paved districts the first wash contains dust, manure and much organic matter, which at times makes such water almost as foul as sewage. The first wash from the surface should, therefore, wherever practicable, be taken into the sewers and finally disposed of with the sewage; the water running off later, being much cleaner than at first, may be discharged without objection almost at any point along the shores of the Bay or Ocean.

The rainwater coming from rural districts on the Ocean slope may be slightly turbid, but for some years it will not be objectionable in any of the present watercourses or anywhere along the shores of the Ocean.

The difficulties confronting us are confined to the final disposition of the sewage or foul waters, and to this part of the problem, therefore, the most careful consideration was given.

The sewage of a city consists practically of the waste water discharged from buildings. It is the water supplied to the community after it has been used and has received such filth and refuse as can be carried away by flowing water. This dirty

water or sewage carries with it not only rapidly decomposing organic matter, which emits foul odors and causes a nuisance, but it also carries with it germs of disease from the excrements, wash and laundry water, which germs, if improperly disposed of, present dangers to health.

These dangers can be greatly reduced or wholly avoided by a proper construction of the sewerage system and by a proper disposition of the sewage.

There are several methods according to which the sewage of cities has been collected and removed from them. To aid in making the selection, the problem should always be examined both from a financial and sanitary point of view.

With a view of utilizing sewage, it has frequently been suggested to turn it upon cultivated land, expecting that the extraction of any manure that is contained in it, and the use of its water for irrigating lands would yield a profit. An abundance of experience has, however, demonstrated that the manurial value is very slight, and that the chief value lies in the water when used for irrigation.

In the present case it needs no argument to show that the sewage of San Francisco would have no practical value, even for irrigational purposes, inasmuch as it would be necessary not only to carry it in large conduits to a considerable distance, but also to lift it under a considerable pressure with pumps so that it might be delivered upon permanently available grounds. The great expense of doing this removes it from serious consideration.

The problem, as presented in San Francisco, is, therefore, limited to the requirement of removing the sewage so that it will not present a nuisance or be objectionable in any way. There is but one practicable solution to this problem, and that is the thorough dilution and dispersion of the sewage in the large masses of water which surround three sides of the City.

In order to obtain a proper dilution and dispersion, it is necessary to discharge the sewage into currents of water. It is also necessary to prevent any of the sewage either from being discharged immediately at the shores or to return to the shores by drifting.

The best localities for sewage outfalls will, therefore, be at such points where the currents are swiftest and most constant.

A discharge along the Ocean front is not favorable, because there is some danger of sewage stranding at the beach, owing to the slight currents prevailing there and on account of the frequent west winds. The best points are north or east of the City.

When considering the question of disposal, it is necessary to examine and provide for the most unfavorable conditions. If these will allow of a proper disposal, then there can be no objection at any other time or place.

The minimum range of tide is stated to be 3.1 feet. The area of the Bay upon which the tide will always rise and fall is at least 300 square miles after all of the tidal flats have been redeemed and developed. Therefore, in the most unfavorable instance every tide will allow over 25,000 million cubic feet of tide water to enter the Bay and again to flow out of it, taking with it whatever fresh water enters from the streams and whatever sewage it may have received, and of which but an insignificant portion could return with the subsequent tide.

From the well established data regarding the safe dilution of sewage, it can be readily calculated that under the most favorable conditions the Bay could receive, by a proper dispersion and dilution, the sewage of over 30,000,000 of people without becoming even noticeable. There is, therefore, no question but that the sewage of San Francisco can be properly disposed of into the tide water of the Bay.

In order to ascertain the best points at which to discharge the sewage, float observations have been made to indicate the direction of current and the degree of dispersion at different stages of the tides. The results fully verify what was anticipated from the hydrographic conditions of the Bay and justify the selection of the outfall points designated in the plan.

The rapidity of the tidal currents and the depth of water into which the sewage may be discharged will at once effect such a dispersion as to make it altogether unnecessary to consider a temporary storage of sewage during incoming tides, any more than naturally occurs in submerged sewers. The quantities of water passing the outfall points at both tides are sufficiently great to make such storage unnecessary.

The points of outfall which have been selected by the Engi-

neers are between Point Lobos and Fort Point, at the foot of Scott street, at North Point, and at Hunter's Point. By far the largest quantity of sewage, about 90 per cent. of the whole, will be discharged to the north of the City, and about 10 per cent. of the whole at Hunter's Point. This distribution is specially advantageous because the dispersion of the sewage thus obtainable will be somewhat in proportion to the amounts discharged. Owing to the fact that there is no necessity for discharging directly at Hunter's Point at the present time, because the quantity of sewage would be very small, and owing to the fact that the insufficient development of the territory would make such an outfall expensive for grading, filling, etc., the Engineers suggest a temporary outfall near the foot of H street South. This expedient is quite proper and will be justified for a number of years, until the conditions indicate the early approach of a nuisance and the desirability that the ultimate outfall should be reached.

As already intimated, the actual outlet should in every case be in the current, as far from the shore line as practicable, so that a large body of water can pass between the outlet and the shore line and thus prevent sewage matter from stranding along the shore.

To avoid a discharge of the sewage from the Ocean slope along or upon the Ocean beach, it has been found practicable to intercept the same, to pump it and discharge it into the current beyond Point Lobos. The attractive features of the beach fully justify the slight additional expense in thus absolutely preventing any possible nuisance that might be caused by the discharge of sewage along the beach.

From the above it may be expected with perfect confidence that the final disposal of the sewage of San Francisco at the points and in the manner indicated by the Engineers will be wholly satisfactory both as regards economy and sanitation.

MAIN COLLECTORS FOR THE SEWAGE AND RAIN-WATER.

The topography of the peninsula of the City and County of San Francisco is well defined by a ridge running in a northerly direction almost through its center, and thus dividing the area

into two main districts, one sloping towards the Bay and the other towards the ocean. Each one of these halves has been subdivided into several sub-districts by the natural valleys which drain the areas by creeks or other small watercourses.

While the most economical disposition of the rainwater is thus indicated, the main sewers for collecting and disposing of the sewage, being of smaller quantity than the rainwater and more easily diverted, can be so altered as to be taken from one district into another by tunneling through the separating ridges. The latter expedient has been adopted by the Engineers in several instances for the purpose of securing better outfalls and greater economy in securing the earliest possible relief in some outlying districts.

A thorough study has been made, and the essential features designated of the best method of collecting the sewage of the entire area of the City, with the exception of a small area comprising a part of the Visitacion Valley, which may be readily provided for at a future time, the Golden Gate Park, all U. S. Government property, and the area near the Laguna de la Merced, now private property and not yet sufficiently developed to require sewerage. Golden Gate Park sewage will always be small in quantity, and can be discharged into the sewers of adjoining districts wherever convenient.

The sewage and rainwater may be collected according to two methods, the combined and the separate. As already stated by the Engineers, the preference is determined by the relative expense, both methods being equally satisfactory from a sanitary point of view.

The Combined System is preferable where both the rainwater and sewage must be carried off underground and can be discharged by gravity. The Separate System is usually preferable where sewage must be pumped, and sometimes where rainwater may be discharged at a near point, but where sewage must be taken to a more distant outfall; also where the rainwater may be kept on the surface for years to come while sewage removal is immediately required. The Separate System may, therefore, become a double system.

In San Francisco both methods can be advantageously used, according to the specific requirements of, and conditions in, each

district. Your Engineers have carefully considered the questions and have in each district given the preference to the system best adapted to local conditions with due regard to economy. To use both in the same city is, however, neither objectionable, nor should it be confusing in any way, because the sewers are to be built according to established plans, filed and recorded, and under the supervision of intelligent officers—a necessary provision which underlies the successful working of any sewerage system whatsoever.

The Bay View District is sewered on the Separate System because its sewage requires pumping, and is as yet so sparsely populated as to make an underground rain water removal unnecessary at this time. The same may be said of the Lower Islais Creek District.

The Mission Flats and Yerba Buena Districts are provided with the Separate System, because the existing sewers are, to a large extent, improperly built for sewage conveyance, yet can be readily used for the reception and discharge of storm-water alone, thus requiring the construction of the smaller and less expensive Separate System, limited to removal of sewage alone.

The West Richmond, the Lower Sunset and the Ocean View Districts are provided with the Separate System because the sewage must be intercepted and carried to the Golden Gate, while the storm-water can readily be left to discharge along the Ocean beach, and because any underground conveyance of such storm-water will not be necessary for many years, except along very few main lines.

The other areas are to be served with a Combined System, receiving both storm-water and sewage. At a number of points, however, where practicable and desirable, and for the purpose of lessening the cost, storm-water overflows, or relief channels, are provided to allow excessive rainwater to discharge at nearer points than if carried to the sewage outfall.

The spillways have been designed to prevent an overflow until the sewer is nearly filled with rainwater, and also to prevent a material rise in the hydraulic slope by giving them a long and low section. These reliefs do not operate until after the sewage has been somewhat diluted, and after much of the accumulated deposits have been washed out to the sewage outfall. They then operate only for the short period during which the excessive

rain lasts. This fact allows of a complete dispersion and removal of the escaping rainwater within a short time, and prevents an accumulation of any sewage matter that might be discharged by these overflows. Experience has shown that if the discharge outlets of the overflows are properly placed, no offense will be caused by them at any time.

Some of the districts are sewered partly with the Combined and partly with the Separate or Double System, such as the Islais Creek District, because a portion of it has already been sewered, and because it was desirable to utilize the existing works as much as practicable. The sewers intended for the removal of sewage are usually laid deep enough to receive also the ground water from cellars and thus act also as drains. In such a case it is important to prevent the occurrence of back flow.

It is beneficent, as suggested by the Engineers in the case of the Separate Systems of the Ocean slope, to turn the ordinary dry weather flow of the natural watercourses into the separate sewers. It not only removes it from the surface during such times, but tends to keep the sewers in a better condition.

A somewhat difficult problem was the quantity of rainwater for which economical provision should be made in the new structures. There was formerly a lack of information in this City with reference to the greatest amount of rainfall within periods of less than a day. Not until within the last two or three years, and through the efforts of two of the Engineers connected with this work, has it been possible to obtain some data on this important question, namely: What is the greatest rate of rainfall in short periods of time during which the water running off the ground will enter and pass off through the sewerage system?

By means of these recent data, although limited in number, a diagram and curves have been prepared, and by means of sound reasoning a safe basis has been established upon which to determine the necessary capacity of the sewers. The Engineers say that the occurrence of rainfall rates "in excess of the amounts indicated by these curves is highly improbable" in San Francisco, with which statement I can agree. They further call attention to two facts, both of which provide a factor of safety, that the heaviest downpours do not extend over a large area, and, therefore, do not at once tax the capacity of a whole district, and

that the available space within the sewers admits of some storage before their capacity is exhausted.

The percentage of run-off has been assumed in accordance with experience obtained both here and elsewhere; but all of the results have been adapted to local conditions, such as the extensive areas having steep slopes, the extensive garden areas in the residence part of San Francisco and the porosity of the soil.

The ground water which will seep into the sewers, when these are built below the general ground water level, and also such ground water which it is intended to drain into the sewers for the purpose of drying the soil, will naturally vary in quantity according to the specific locality. This question has been given due consideration by the Engineers, and allowances for the proper quantities have been made.

The quantity of sewage is usually measured by the population which the sewers are expected to serve and by the quantity of water that is supplied to the population and runs off as sewage.

The present population has been ascertained as carefully as was necessary for the purpose, and the future growth of the City, not only as a whole, but in the several districts, has been carefully estimated. In some cases it was necessary to make assumptions for a growth that may never be reached, because it is impossible in all cases to be sure of the directions in which the city is most likely to expand, and of the character of the buildings that will occupy certain districts, and thus of the quantity of water that will be used. It is, therefore, customary, and it has been done in this case, to make liberal allowances where the future cannot be predicted with reasonable certainty. It might be added that the local sewers, as well as the main collectors, for the areas improved at the present time, are intended to be made sufficiently large to permanently serve the districts so far as the sewage removal is concerned.

The amount of sewage to be provided is approximately gauged by the water consumption. The available data indicate that this consumption is smaller in San Francisco than is usual in the large American cities. Yet it is greater than in the large European cities.

The conditions recited in the report apparently justify this almost exceptional fact, and, therefore, the assumptions that have

been made for proportioning the sizes of the sewers. It may be well to say, however, that in the case of combined sewers, the entire quantity of sewage is hardly worth taking into account at all when compared with the elasticity of the rainfall assumption and in the case of separate sewers, any future deficiency, if it is ever found to exist, could be readily and economically corrected by the building of parallel, but small and inexpensive sewers at a later time, an expedient which, if the time is long, is sometimes even found to be economical.

The intercepters, below the points where rainfall overflows are provided, are proportioned so that the maximum flow of sewage will cause them to run but one-half full, and the ordinary flow of sewage but about one-quarter full. As the overflows operate only when the sewer runs nearly full, an allowance is thus made for diluting the sewage escaping at the overflow, with twice to four times its quantity of rainwater, which from long experience, under conditions similar to those prevailing here, has been found unobjectionable.

Before the overflow takes place, the natural flushing of the sewers by the first flow of rainwater cleanses them more or less thoroughly, and the diluted sewage which escapes thereafter is less offensive than it would be before such flushing.

The discharge of this water into the harbor at the pier heads will not even occur at every rainfall. From the diagrams, it is estimated that an overflow will occur on the average but twenty-six days in the year, and will continue only as long as the fall is heavy. The natural currents and tidal circulation will, under such conditions, prevent any offensiveness or accumulation of sewage at the outlets.

In designing the system, one of the most important conditions to meet was the collection and discharge of the rainwater and sewage by gravity; that is, without pumping. The Engineers gave considerable study to obtain this object, and have succeeded in reducing to a reasonable minimum the areas from which it is necessary to artificially raise the sewage so that it can be discharged at proper outlets. To accomplish it they have studied the best available gradient and the least expensive alignment of the intercepters which prevent the sewage of the higher territory from naturally reaching low territory, where it would thereafter

require pumping. To gain this object even tunnels have been suggested, as they were found to effect economical solutions in a few instances. The alignment also of the main collecting sewers has been carefully studied with a view to economy and efficiency.

These main sewers have been placed so that they carry the sewage as rapidly as possible to the outfalls without facilitating a deposit of solid matter any more than is unavoidable in such cases. The most available and least obstructed streets have been selected, and the collectors have been given such a depth as will readily serve their purpose.

As already mentioned, ridges have been pierced by tunnels to secure a better service, and, in some cases, also at a less expense. The longest tunnel is one which intercepts the sewage from above the intersection of Mission Road with Islais Creek and discharges into the sewer going to North Point, instead of allowing the sewage to follow its more natural course to Hunter's Point and the Bay.

The pumping stations have been provisionally located and have been arranged with reference to economy and efficiency. A special study has been made regarding the best character of machinery and the most expedient power to use. The centrifugal pumps have rightly been given the preference for sewage lifting at all stations excepting one where the high lift required at the present time makes a reciprocating pump more economical. At the same cost of operation a centrifugal pump is preferable for lifting sewage, because the heterogeneous character of sewage and the suspended matter which it carries, passes through the pump with no danger of disturbing the flow, while the valves of a piston pump may become blocked by an obstruction and require special attention.

The receivers which are required to store some of the sewage temporarily, and to facilitate the operation of pumping, have been considered in sufficient detail to allow of a safe estimate to be made of their cost.

The existence of a sewage pumping station in the heart of a city is not at all objectionable, as experience has demonstrated. With proper attention there would be no more odor arising from it than from a properly kept sewer in the street.

The street grades in some parts of San Francisco have not

been established with a view to getting a proper surface drainage. So-called pot-holes occasionally exist from which the water can only be removed if the sewers or drains, and particularly the inlets to them, are in good order and unobstructed. There are also sections of the City where the established grades are so low that it is impossible to secure a surface discharge from them at proper points at the shore.

The Engineers have fully explained these as well as other defects now existing, and which can only be remedied by a revision of the street grades. I cannot too strongly support their recommendations in this respect, because a raising of grades at the present time is not only less expensive than when streets are built up in the future, but it enables the sewers to be placed at better grades, which will permanently improve their operation and condition. This elevation also improves the value of the adjoining property by reducing the danger from flooding during excessive storms, and by securing a dryer and more healthful subsoil under the buildings.

But not only should certain street grades be revised. It will often be advantageous to adjoining property to have new streets laid out on lines that are necessary for main or intercepting sewers. This will be the case particularly along valley lines where water courses of irregular alignment now exist, and where the property could be put to better use if thus improved and damages by flooding avoided. Also along hillsides the best line for an intercepting sewer may also be the best line for a main street to avoid the crossing of a hill.

Wherever it was found impracticable in the new system to utilize the existing large valley line sewers for sewage removal, these sewers have been converted into rainwater overflow channels, relieving the new intercepting sewers of all excessive flow during storms. Much credit is due to the Engineers for having converted almost every part of the present imperfect system into useful parts of the proposed new system by judicious alignments and adjustments.

LOCAL SEWERS AND DRAINS.

While the main alignment of a proper system of sewerage as mentioned above forms its most important part, a proper design of the local sewers and drains, and of the details of the entire sys-

tem is almost as important, in order to accomplish the desired object of having a perfectly sanitary system. From a sanitary point of view the local sewers, in fact, are sometimes even of more importance because they are in immediate connection with the houses.

Together with the construction of the mains there should go a remodeling of the branch or lateral sewers which now serve most of the populated part of the city, because these sewers now cause much of the trouble complained of, and which will not be entirely removed by the construction of the proposed main sewers and the proper disposal of sewage.

A full description of the defects of the present system is contained in the Report of the Board of Engineers of 1893. Their present report is intended to indicate how these defects can be remedied.

So far as the existing sewers answer proper constructive and sanitary requirements, they should be preserved and are embodied as parts of the new system. Others may be repaired or in part remodeled, thereby also made entirely efficient and hereafter serve their originally intended purpose. Still others should be entirely replaced by new structures as soon as practicable.

In several instances the existing sewers are of insufficient capacity, as, for instance, on Channel street, Fourteenth street, and on other streets. Yet they have been given a place in the system to serve up to their full capacity, and necessary relief sewers conducting the excessive rainwater have been provided either on the same or on parallel streets.

Some of the existing sewers, while having sufficient capacity for the present, will not be large enough in the future. In such cases a reconstruction or the construction of supplementing sewers is properly postponed to such a time when the necessity for having them will present itself.

In such districts where the Separate System has been recommended, a future provision will have to be made for an underground removal of the storm-water whenever the run-off becomes sufficiently great in quantity to be objectionable when flowing on the surface. Such drains can be built as needed. As the contents will not be foul water, it is practicable to build the drains for short distances and occasionally omitting their construction

at intervals and leaving gaps without causing a nuisance, which omissions or gaps would not be practicable if these drains were to be used as sewers to carry sewage.

ESSENTIAL CONSTRUCTIVE DETAILS AND MAINTENANCE OF WORKS.

The constructive features of the new sewers have been designed on the best principles now known to the profession. The sewers have, in the first place, been given a sufficient gradient, wherever practicable, to prevent undue deposits, and have been given the best sectional shape to secure the most effective flow. They have been given such dimensions as experience has warranted, and it has been assumed in the estimate of cost that they are built of durable materials, with skillful labor and under proper supervision.

In the design presented to you, all the essential details and appurtenances have been given due consideration, and the cost thereof has been estimated.

The daily mean velocities are sufficient to remove the usual suspended matter. In some cases the diminished flow during the night may, however, allow of a slight temporary deposit in some of the sewers of the low districts; but the greater flow during the day will be able to refloat most of it and carry it off. Owing to the fact that a sewer is liable to receive matter of all kinds and in all conditions, it is impossible to prevent occasional deposits. Artificial means must, therefore, be adopted to remove them, as will be mentioned below.

Among the important details of a sewerage system are the bends, turns and junctions which must be carefully designed and constructed according to the laws of flowing water so that eddies, back flow or other disturbances of the current may be avoided. In former times insufficient attention was given to these simple principles, and in many cases has been the sole cause for offensiveness, which at one time even gave rise to serious objections against sewerage systems in general.

Another important feature which has only lately been thoroughly appreciated, is the necessity for giving sewers a smooth interior surface upon and against which the sewage flows. This smoothness not only increases the velocity, but its main advan-

tage is that it prevents the adherence and retention of most of the foul particles and their subsequent putrefaction in the sewer.

In short, a modern system of sewerage requires considerable attention given in general and in detail to all of the means necessary to secure the most rapid and complete removal of sewage matter from the moment it enters the sewers at the houses to the moment when it reaches the point of its final discharge.

To prevent a permanent accumulation of deposits, where temporary deposits cannot be avoided, it is necessary to introduce means for flushing the sewers by which such deposits are inexpensively and can almost always be effectively removed. Flushing means nothing more nor less than a temporary increase in the quantity of flow in the sewer, and, therefore, also of the velocity of the water. This increase produces a slight scour and carries off with it material that the ordinary low flow would allow to remain deposited.

Flushing is naturally secured in a Combined System of sewers by a heavy rainfall. In a Separate System of sewers, or, during a dry season when there is no sufficient rainfall for several months, the flushing must be secured by artificial means.

This means consists partly in the introduction of flush tanks at the heads of the sewers, filled with water at any time and suddenly discharged, thus allowing an increased quantity of water to pass down the sewer for a short time and for some distance.

While the flush tanks accomplish the desired object for the upper stretch of a sewer, they accomplish practically no flushing after the water has run several blocks. A flushing of the lower stretches of the larger sewers is most economically accomplished by the introduction of flush gates, by which the sewage can be temporarily penned up, and, by suddenly releasing them, allow an increased quantity of sewage to flow down the sewer for a short time. A sufficient number of flush gates, if properly placed and repeatedly operated, will readily cause a cleansing of the entire sewer.

Lastly, a word should be said regarding the proper ventilation of a system of sewers. It is necessary to maintain atmospheric pressure throughout the underground system, in order to prevent the rising and falling of the flowing sewage from compressing or

rarefying the air within the pipes, and thus blowing out or siphoning the main trap and the traps at the fixtures in the buildings. Considerable trouble has been caused from ignoring this fact.

To maintain atmospheric pressure, it is customary to give the manholes of the sewers perforated covers. These manholes are placed along the sewers at frequent intervals, in order to make them accessible for examination or cleaning. Another method is to allow the main pipes of the houses to remain untrapped, from the public sewer connection to a free outlet above the roof of the house, trapping only the different fixtures within the house. Either method will accomplish the purpose, and the preference depends upon local conditions.

Wherever the sewer air escaping from perforated manhole covers is found to be objectionable, the permanent remedy lies not in sealing the covers, but either in the more thorough cleansing of the sewers or in the carrying of the sewer air through the soil pipes of the houses to above the roofs. The latter expedient is a customary one on the continent of Europe, and also in a number of American cities. In England it is preferred to carry a special pipe outside of the buildings to above the roof, where such ventilation is necessary, in addition to what is ordinarily obtained by perforated manhole covers.

Owing to the many steep slopes of the sewers in the City of San Francisco, there will be a tendency for the sewer air to escape in large quantities at the highest openings. To prevent the escape of this accumulated foul air, it has been properly suggested to provide flaps at manholes on steep slopes, which will cause the air of but a section of the sewer to escape at any one manhole, and thus obviate or reduce the offensive conditions.

From what has been said above, it will be seen that to have a satisfactory sewerage system, it is necessary not only to secure a proper general design, but to give considerable attention also to its details, and to the subsequent maintenance and operation of the system under competent and experienced supervision.

ESTIMATE OF COST.

The estimates of cost are based upon the ruling prices for first-class material and workmanship in all details, with proper

allowance for superintendence and the contingencies incident to this class of work. They aggregate $4,600,000.00. This compares favorably with the expenditures for similar purposes made or contemplated in Baltimore, Boston and Washington, with these important exceptions, that San Francisco, under the proposed system, and included in the cost estimate, is extending the sub-main and branch sewers into districts now but sparsely settled, but which are rapidly increasing in population, and there is included in the estimate the cost of constructing two complete separate systems for important districts now closely built up and inadequately sewered.

The construction of the system of sewers now proposed will afford your city a relief from conditions which have long been a drawback and just cause of complaint, and will put it well to the front in the matter of thorough sanitation and drainage.

Very respectfully,

RUDOLPH HERING,
Consulting Engineer.

APPENDIX B.

COST OF SEWERS NOW IN USE.

(From the Report of 1892-93, corrected and extended.)

The following table has been compiled from the published reports of the Superintendent of Streets, from 1859 to 1899. Where definite information was lacking, data to complete the table were approximated.

The cost of sewers, though based on the estimates made from year to year, is not to be regarded better than a fair approximation. In some instances the cost of improving street corners was included, in others omitted. When sewers were reconstructed or replaced by new sewers the length and cost seem to have been carried into all the records the same as new work. The aggregate length of the sewers now in use will, therefore, fall short of the aggregate shown in the table.

No estimates of cost were made by the Superintendent of Streets during the last six years. Average prices as determined by the preceding five years were used in completing this part of the table.

Since 1883 the cost of manholes and the cost of catch-basins (cesspools) are noted as separate items in the official report, but in the case of catch-basins their cost is generally given in connection with the improvements of street crossings or corners, and the labor of now attempting a complete segregation did not seem justified, particularly as the rates adopted by the several Superintendents of Streets in estimating the cost of different kinds of sewers have varied greatly.

According to the data in the table, the aggregate length of all kinds of sewers constructed to June 30th, 1899, including the length of rebuilt sewers, is 1,613,013 feet, or 305 2613-5280 miles:

YEAR.	REDWOOD SEWER.		BRICK SEWER.		CEMENT PIPE SEWER.		IRON STONE PIPE SEWER.		MANHOLES.		CESS-POOLS.		RECONSTRUCTION COST.
	Length in Feet.	Cost.	Length in Feet.	Cost.	Length in Feet.	Cost.	Length in Feet.	Cost.	NO.	COST.	NO.	COST.	
1858-59	1,740	$670	900	$4,883									
1859-60	955	3,398	4,198	22,633									
1860-61	760	1,897	5,725	30,830									
1861-62	1,606	4,882	10,308	61,916									
1862-63	5,889	21,640	13,344	116,709									
1863-64	7,646	27,975	20,012	173,389									
1864-65	5,272	29,060	20,967	287,200									
1865-66	9,260	39,068	24,414	203,920									
1866-67	12,137	49,578	21,303	156,745									
1867-68	11,150	47,424	30,650	237,798									
1868-69	11,908	50,098	36,630	365,598									
1869-70	8,695	53,530	23,144	213,481									
1870-71	1,320	5,468	11,147	62,215									
1871-72	6,496	17,534	1,648	8,798	6,534	$11,165							
1872-73	2,561	6,063	10,998	59,316	5,139	11,454							
1873-74	2,362	8,903	15,921	84,389	4,866	10,373							
1874-75	5,135	11,415	28,401	162,437	9,321	21,052							
1875-76	6,140	14,359	46,564	256,198	16,454	36,821	9,598	$21,864					
1876-77	8,270	26,954	46,330	346,785	24,492	64,431	24,035	59,654					
1877-78	3,300	6,707	16,223	100,417	9,261	18,081	21,928	47,826					
1878-79	3,021	5,955	8,071	42,233	2,949	5,900	11,400	21,841					
1879-80	1,550	3,098	9,465	49,552	2,201	4,691	8,694	20,462					
1880-81	520	1,260	413	2,168	.....	.....	8,278	19,870					
1881-82	.....	.....	550	2,887	1,086	2,172	1,552	3,725					
1882-83	.....	.....	1,414	7,424	275	550	4,237	10,170					
1883-84	470	1,642	7,193	41,717	275	550	12,966	27,229	63	$2,520	68	$9,520	
1884-85	1,724	6,410	14,183	89,765	.....	.....	27,135	61,459	134	3,350	111	13,875	$110
1885-86	481	1,924	10,850	59,675	.....	.....	38,364	86,319	166	4,150	120	15,000	5,639
1886-87	316	1,106	6,244	34,342	.....	.....	27,495	68,737	113	4,520	53	8,000	243
1887-88	.....	.....	12,039	66,215	.....	.....	63,849	159,623	225	7,875	298	37,250	
1888-89	.....	.....	2,062	11,341	.....	.....	72,457	144,914	303	10,605	265	33,125	
1889-90	.....	2,975	10,818	54,090	.....	.....	77,183	154,366	372	13,126	262	46,500	
1890-91	.....	2,427	12,503	62,815	.....	.....	103,136	195,959	351	14,040	317	38,040	82
1891-92	.....	67	37,301	266,824	.....	.....	85,955	154,719	380	13,300	231	31,375	
1892-93	.....	.....	2,328	14,500	.....	.....	57,371	85,957	195	6,825	86	6,450	
1893-94	.....	.....	1,528	9,626	.....	.....	25,551	47,525	74	2,676	30	4,018	6,769
1894-95	.....	.....	14,950	94,185	.....	.....	53,277	99,095	257	9,393	105	14,063	
1895 96	.....	.....	8,653	54,514	.....	.....	51,169	95,174	245	8,859	174	23,303	
1896-97	.....	.....	543	3,421	.....	.....	21,275	39,571	114	4,122	151	20,224	647
1897-98	.....	.....	3,904	24,595	.....	.....	28,638	53,267	158	5,714	97	12,991	1,049
1898-99	1,047	22,942	1,137	7,163	.....	.....	18,910	$5,173	99	3,580	47	5,295	
Totals	121,731	$476,429	554,976	$3,954,709	82,853	$187,240	853,453	$1,714,499	3,249	$114,649	2,442	$319,029	$14,539

APPENDIX C.

TOPOGRAPHICAL FEATURES OF THE CITY AND COUNTY OF SAN FRANCISCO.

[Reprinted from the Report of the Engineers in Charge to Devise and Provide a System of Sewerage, 1893, with slight additions and some omissions.]

San Francisco is built on the peninsula lying between San Francisco Bay and the Ocean. It covers the entire northern portion of this peninsula, fronting westward upon the Pacific Ocean, northward on the Ocean, the Golden Gate and the Bay, and eastward on the Bay. Its southern boundary is an east and west line from Ocean to Bay, lying about seven miles south from the Golden Gate.

The exterior form of the City may be described as an irregular square, with sides nearly conforming to the cardinal directions, except that the central portion of its northern front juts out at Fort Point beyond a right line, and that its western and eastern fronts bear somewhat east of south instead of due south.

The spur of the Coast Range mountains, which has its northern terminal at the Golden Gate, has no point within the City rising to the dignity of a mountain, although several gracefully rounded peaks—Las Papas, or Twin Peaks, and Blue Mountain—near the center of the City, rise to a height of over 900 feet.

The peninsula spur of the Coast Range divides the City, as above described, into two main watersheds, of which one sends its drainage toward the Ocean, the other toward the Bay. The dividing line between these two slopes enters the City limits from the south a little west of the median line, and holds a quite direct course to Fort Point.

The lowest points of this summit are over 200 feet high. The northern division of the Southern Pacific Railroad and the Mission, or County, Road cross the same south of Twin Peaks; parts of Golden Gate Park and Richmond lie upon the flat top of the summit north of this central group of hills.

The principal spurs from this peninsular backbone subdivid-

ing the eastern watershed are: Hunter's Point ridge, to the south of which lie two small valleys opening toward the Bay, of which the southernmost, Visitacion Valley, is partly in San Mateo County; Bernal Heights, between the two branches of Islais Creek; the Potrero Hills, which are barely connected with the main ridge by a slight swell in the ground, and the Northern Ridge, terminating in Russian and Telegraph Hills, on the northeastern Bay front of the City.

The western watershed is subdivided by the Point Lobos spur of hills and by the flat-topped Ocean House ridge into three drainage basins, of which the northernmost is tributary to Mountain Lake and Lobos Creek; the second embraces a region of shifting sand dunes extending well up on the western slope of the Twin Peaks Hills, and the third sends its waters into Laguna de la Merced.

The several spurs of hills which thus establish a number of natural drainage districts, in most cases terminate rather abruptly. The terminal group of hills on the Point Lobos ridge rises to an elevation of 330 feet, one of the highest of these hills being only about 1,000 feet from the shore line; on the Fort Point ridge, about a mile south of the Golden Gate and only a quarter mile from the Ocean shore, is a prominent elevation over 400 feet high.

The Presidio Heights, near the point where the Northern Ridge leaves the main ridge, have greatest elevations of 300 to 380 feet.

Lafayette Square rises to a height of 380 feet; Clay-Street Hill to 360 feet high; Russian Hill is 370, and Telegraph Hill is over 200 feet high. The lowest point on the spur which extends northwesterly from Russian Hill and terminates at Black Point is about 90 feet high, and Black Point itself is 100 feet high. On the Potrero Hills are points nearly 340 feet high, and on the Hunter's Point ridge several hills rise to over 250 feet. Railroad avenue crosses this ridge at an elevation of 80 feet, and San Bruno Road at 60 feet. The spur extending eastward from the Hunter's Point ridge, near the south line of San Francisco, leaves the main ridge at an elevation of 550 feet. It is crossed by the San Bruno Road at an elevation of 140 feet, and terminates in a hill whose top is nearly 500 feet high.

Bernal Heights rise to an elevation of over 490 feet; Buena Vista Peak is nearly 550, and Lone Mountain nearly 430 feet high.

Between the several ridges or spurs of hills, as above referred to, lie valleys or broad, flat slopes opening out upon the Bay or Ocean. The basin south of the Point Lobos ridge has no well defined line of drainage. Irregular sand dunes, formed of sand blown eastward from the beach, form a broad, broken slope to the Ocean.

The drifting sands have been carried over the main peninsula ridge to the northward of the Twin Peak group of hills, and, separating into two parts at Lone Mountain, found lodgment in a broad belt extending eastward and southeasterly across the peninsula to Mission Bay, and in lesser quantity on the southern slope of the Northern ridge.

The sand from the northern beach westward of Black Point has drifted southeasterly and easterly, piling up great sand dunes to the southward of Black Point in the vicinity of Lobos Park, and terminating on the western slope of Russian Hill and the northern slope of the Northern ridge.

Where sand has thus drifted over portions of the site of the City it covers clays, shales and serpentines. At points where the surface has not been covered with sand a clay soil predominates.

The northern and eastern shore of the City is indented by arms of the Bay, which extend well within the ultimate shore line as proposed for the City. As the built-up area of the City is extended these are filled in; but the districts thus reclaimed are low and flat, yet in many cases of great extent. That part of the City east of Montgomery and south of Clay street is largely of this character. Mission Bay has been nearly closed against tidal waters, but the extension of the built-up area over its surface has not been rapid because there has been ample opportunity for the growth of the City in other directions. Street grades in the Mission Bay district throughout an area of about 150 acres have been established at City Base (City Base being 6.7 feet above an ordinary high tide). Islais Creek, south of the Potrero Hills, opens to the Bay through broad mud flats covered to the extent of about 500 acres by the City. As far inland as Fifteenth avenue and San Bruno Road, about two miles from the water front,

street grades have been established as low as one foot below City Base.

South of Hunter's Point an area of seven to eight hundred acres within the City limits extends out into the Bay over low mud flats which will some time be filled to about City Base.

On the northern front of the City tidal area and Bay surface that will fall within the proposed seawall line aggregate about 270 acres.

It is interesting to note that, although San Francisco is built on hills and undulating ground rising high above the level of the sea, it embraces within its limits several thousand acres of salt marsh and Bay surface, portions of which have been filled in and are built upon, but by far the greater portion of which remains to be reclaimed in the ultimate growth of the City.

The area of San Francisco, including the lands already reclaimed and to be reclaimed, estimated to the officially established water-front line, is 30,680 acres (about 48 square miles). The area already built upon covers about 8,000 acres, covering almost the entire northeastern quadrant of the City as above described and extending in a long, narrow strip several miles westward from the densely populated region, along Point Lobos avenue and neighboring streets; also extending southward along the principal lines of travel, San Bruno Road and Mission Road, with occasional spots, as in the Potrero and South San Francisco, where an aggregation of residences and other buildings marks a nucleus of suburban growth.

ISLAIS CREEK DRAINAGE BASIN.

In the discussion of volumes of flow from the Islais Creek drainage basin and from the Laguna de la Merced drainage basin, the fact is not to be lost sight of that provision must be made for natural drainage from portions of their water-shed beyond the southern boundary of San Francisco. This is true also, though to a lesser extent, in the case of the Visitacion Valley drainage basin.

Mission Road and San Jose Road both lie within this district from points near Holly Park to the County line. The open

waterway of Islais Creek is the drainage channel of this district and into this creek a few local sewers deliver their flow.

The creek takes a course through private lands, some of which have not been subdivided into blocks. When they are to be subdivided and streets are to be laid out through them, special attention should be given to the matter of drainage, because it will be necessary to so locate the streets that a proper alignment of the sewers will not be interfered with.

Islais Creek receives water from a small portion of the northern slope of San Bruno Mountain, south of San Francisco, from the northeastern slope of the Twin Peak group of hills and from the entire southern slope of the Bernal Heights. It drains a suburban region of considerable importance that is rapidly being built up.

The main creek is formed by the junction of two branches, of which the northern branch descends from the Twin Peak slopes, crosses under San Jose Road and the Southern Pacific Railroad track, and meets the southern branch in the depression between San Jose Road and the County Road. The creek flows thence in a northeasterly direction to the base of the western slope of Bernal Heights; thence gradually opening to a broad expanse of tide marsh sweeps around the southern and eastern base of these hills in a long curve, and, receiving Precita Creek from along the northern base of these hills, terminates in the tidal basin that has been formed by the grading of Kentucky street from the Potrero to South San Francisco.

Islais Creek is by statutory enactment declared to be navigable "from Franconia Landing, near Bay View turnpike, to its outlet into the Bay of San Francisco, and thence easterly along the southerly line of Tulare street to the City water front on Massachusetts street, of the width of the channel of said creek." Notwithstanding this statute, Kentucky street has been filled across the creek and across Tulare street, and the connection of the land-locked tidal basin, west of Kentucky street, with the Bay, is confined to a large wooden box culvert under Kentucky street.

This basin is the recipient of the flow of Islais Creek and of Precita Creek, which near its junction with Islais Creek receives the discharge of Army-street sewer.

Just above Franconia Landing the Islais Creek tide marsh is

crossed by the extension of Fifteenth avenue, the official grade of which has been established at one foot below City Base or only 5.7 feet above ordinary high tide, although, as already stated, this point is about two miles in a direct line from the proposed water front of the City and is one mile and a quarter above or west of Kentucky street. Kentucky street grades across the Islais Creek marsh lands are at City Base. It is very evident, therefore, that the low grades on Fifteenth avenue and San Bruno Road, still further west, where they are fixed at about City Base, were ill-advised and need revision.

PRECITA CREEK DRAINAGE BASIN.

Precita Creek water-shed is separated from the Mission Bay District by a spur from the northeastern slope of Twin Peaks, which has its last prominent eminence at Twenty-first and Sanchez streets, by the Potrero Hills and by the gentle swell at the head of the Mission Valley, which turns Precita Creek southward to an outfall between Potrero Hills and Bernal Heights into Islais Creek. As a waterway the creek, except throughout the last half mile of its course, has been supplanted by Army-street sewer, but to the north of Army street there is still much low wet marsh ground, some of which is kept foul by the outflow of local sewers, the most notable of which is Potrero-avenue sewer, which terminates at Twenty-fifth street.

At the present writing Army-street sewer discharges its flow through a break in the side of the sewer just east of San Bruno Road in the Precita Creek channel, whence after spreading out over several acres of the marsh land it reaches the main channel of Islais Creek.

The break in Army-street sewer here referred to is in the side of a wooden box which was put in as an extension of the brick sewer that terminates at San Bruno Road. This wooden box has been carried along Army street to Kansas street and thence to Marin street, in which street it terminates at a point about 50 feet east of Kansas street. During the storms of last winter, which caused a settling of the fill on top of this wooden sewer, it was crushed at several points and the accumulation of pressure due to the stoppage of flow was probably the cause of the break near San Bruno Road. (These conditions still prevail.)

MISSION BAY DRAINAGE BASIN.

From Potrero Hills on the south to the Northern ridge on the north, and extending westward to the Twin Peaks, is a drainage basin of large extent, embracing more than 4,000 acres, most of which is densely populated, including as it does the heart of the city, the entire Mission and the entire Western Addition. All the drainage of this region, except small portions intercepted by Brannan-street sewer, are discharged into the open waterway of Channel street through the feeders of the Channel-street sewer, through Seventh-street, Fifth-street and other parallel sewers, and through small sewers in the Potrero. The discharge from these sewers, representing as it does more than one-half of the drainage of the built-up portions of the City, ebbs and flows in Channel street, impregnating the banks of the channel and the mud in its bed, and coating the piles under the wharfs with an indescribable filth. If there were a large tidal area at the head of the open waterway of Channel street there might be some hope of having a part of the filth carried to the Bay at each ebb tide, but the tidal area is inadequate, and by reason of the rapid encroachment of street improvements it will soon be obliterated entirely. The situation has been made still worse by the dumping of garbage upon Mission Bay lands. The concentration of filth in Mission Bay and Channel street has been a fruitful source of complaint in the past.

Referring to the same subject, in 1874, Henry Gibbons, Jr., M. D., in his official report as Health Officer, says: "Washerwoman's Bay, Mission Bay and Mission Creek are constantly augmenting in filthiness. The difficulties in the way of remedying this evil seem almost insurmountable, although effort has been made, and some work has been done in Mission Bay. It is a happy circumstance for our people that this bay is not to the windward of the City. If any one doubt it let him ride over Brannan or Fourth-street Bridge on a warm day when the tide is low. In regard to Mission Creek much might be said. Few seem to know its extent of filthiness. From away beyond Eighteenth street, where it originates in a pond, down past Sixteenth street, at its intersection with Harrison—the very recollection of which locality by a person who has visited it, is almost sufficient to

sicken—to the outlet in Mission Bay and even beyond, it smells to heaven with a loudness and persistence that the strongest nostrils may not withstand, and the disinfectants of a metropolis could not remove. If by any means it were possible to draw sufficient public attention to these serious evils to cause their speedy removal, I would feel that a better work in the interest of the public health had been accomplished than all else combined."

It is only necessary to add to what Dr. Gibbons has so forcibly said that since the above report was made by him Channel-street sewer has been constructed to Ninth street, its present termination, and the Mission Creek lands were in larger part filled in; but that to the eastward and southeastward of Ninth street the accumulation of filth has been allowed to continue throughout the nineteen years that have intervened, and the discharge of the sewers into the open waterway of Channel street still continue.

The principal sewer of this district is the large Channel-street brick sewer, the lower portions of which are constructed in elliptical form, with large diameter placed horizontally. The inside diameters of the sewer are eleven feet and eight and one-half feet respectively. This sewer following closely the former alignment of Mission Creek intercepts the flow of the several sewers which before its construction discharged into the creek, notably Eighteenth-street sewer, of which Channel-street sewer may be said to be a continuation; Seventeenth, Sixteenth, Fifteenth, Fourteenth and Eleventh-street sewers, all of which are elliptical three feet by five feet sewers of the usual type. Of these sewers those on Fourteenth and Fifteenth streets receive the flow from that portion of the Western Addition drained by the Fell-street system. Nearly all the rest of the sewage from the Western Addition reaches the Eleventh and Seventh-street sewers, of which the former discharges into Channel-street sewer and the latter, crossing Brannan-street sewer, has its outfall point in the open waterway of Channel street. Brannan-street sewer is connected at its upper end, near Tenth street, with the Channel-street sewer, and may be considered a relief outlet of the latter. It is a circular sewer 6 feet in diameter to Seventh street, and from there to First street it is 9 feet wide, 7 feet high, but laid to such irregular grade that its bottom is several feet lower between Sixth and Fifth streets than between Fourth and Third. It intersects the

several sewers on Eighth, Seventh, Sixth, Fifth, Fourth and Third streets, and intercepts Ninth-street sewer. At Rincon Hill, near First and Second streets, this sewer was constructed as a tunnel, and its invert is about 38 feet below official street grade at Second street.

The grade of the Brannan-street sewer does not conform closely to the elevation of the bottoms of the several sewers which it intersects. These are generally from one to three feet higher than the bottom of the Brannan-street sewer, which thus becomes a recipient for the sewage from the entering sections of the sewers. The outgoing sections lying between Brannan and Channel streets may be regarded as relief outlets. As a matter of fact there is generally so much silt and sludge in the Brannan-street sewer that the non-conformity of grade is in most cases obliterated and partition of the sewage flow in Brannan-street sewer occurs at nearly every street crossing.

The outfall of Brannan-street sewer is under the wharf at First street. During the ebb flow the sewage delivered by it into the Bay is crowded inshore under the wharves to the northward by the outflow from Channel street. At flood tides it is carried along shore southward and westward into Channel street.

Aside from the principal drainage lines of the Mission Bay drainage basin, there are sewers on Mission, Howard and Folsom streets, each of which has an independent outfall to the Bay under wharves or piers of the water-front.

The sewage from the northern slope of the Potrero Hills is either dumped on the Mission mud flats by means of small temporary sewers, or reaching the Potrero-street sewer it is delivered into the Bay near the Union Iron Works.

YERBA BUENA BAY DRAINAGE BASIN.

That low, flat portion of San Francisco north of Market and east of Montgomery street, with the slopes of the hills westward to Jones street and northward to the summit of Telegraph Hill is the Yerba Buena drainage basin. It is relatively a small district, but it covers the most important business section of the City. This, together with the fact that about 120 acres of this district have been reclaimed from the Bay, make the sewerage

problem for Yerba Buena Bay district one of particular interest and importance.

It is here, in this old part of the City, that the examples of large intersecting sewers are most striking. San Francisco's Chinatown lies in the center of this basin, on the slopes whose sewage and silt contribute to the deposits annually piled up in the many sewers of this district on light gradients.

To describe the present system of drainage it is only necessary to state that every east and west street from Broadway to Sutter has its 3 feet by 5 feet brick sewer, and that there is a similar north and south sewer on almost every intersected street, and in the lower part of the district nearly every alley, court and place has a similar large brick sewer. Until within a few years there was an outlet for the sewage from these sewers at the foot of each east and west street and at the foot of Market street. Now, however, Market-street sewer has been extended in the form of a wooden box sewer northward along East street to the foot of Washington street. It intercepts Sacramento and Clay-street sewers. Washington and Jackson-street sewers are in a similar manner turned southward on East street and are also connected with the Washington-street outfall.

As Market-street sewer intercepts the several brick sewers of the east and west streets from Geary to Sacramento street, a considerable flow of sewage is concentrated at the Washington-street outlet, which is not at the pier head, but at the low-water line under the wharf. Similarly, the sewers in Pacific and Vallejo streets have been turned into Broadway, and there pass through the seawall to the low-water line. Many of the sewers in this district are in comparatively good condition. The construction of at least one-half of them has been needless. All of the large sewers in the flat portions of the district contain much slush and filth which cannot, under present conditions, be removed by flushing, and which defies the storms of winter.

Utilizing present sewers to the greatest extent possible, particularly for the storm-water flow, it will not be difficult to devise a Separate System for sewage only in the flat portion of this district, and with this combined and relatively inexpensive system, and an interception of the sewage flow from higher portions of the district, to meet every requirement. The utilization of

the present sewers for storm waters will, however, involve a remodeling of many, the reconstruction of others and an abandonment of many of those now on north and south streets.

NORTH BEACH DRAINAGE BASIN.

The North Beach drainage basin includes the Bay frontage from Telegraph Hill to Black Point, with Russian Hill and Clay-street Hill marking western and southern points of its extent. Here, as elsewhere in the City, the sewers have been constructed without system. The district as a whole is favorably situated for thorough drainage, the only difficult portion being the long extent of Bay frontage.

At present the principal sewers are those on Larkin, Hyde, Mason and Powell streets, which terminate at the water line of the Bay.

WASHERWOMAN'S BAY OR HARBOR VIEW DRAINAGE BASIN.

These names have been given to the region extending from the Presidio Heights eastward to Russian Hill and Black Point. The northern slope of the Northern ridge is toward San Francisco Bay. The peculiarities of this district are the steep descent from the ridge at its southern limit and the large extent of the comparatively flat marginal tract, some of which has not yet been reclaimed from the waters of the Bay.

In this district the building area has been extending gradually downward from the hillsides toward the Bay. Sewers for a long series of years terminated in landlocked basins or at the inshore limit of the tidal marsh, and it is only in the last decade that some relief has been afforded by extending some of the principal sewers to the Bay shore.

The outfall points of this district at present are at the Bay shore on Pierce street, on Steiner street, on Fillmore street under the wharf, and on Webster street.

The sewage of the Steiner-street sewer, and to some extent that of the Pierce street, is being utilized during the spring and summer months for the irrigation of Chinese vegetable gardens located near these streets north of Chestnut street.

LOBOS CREEK OR RICHMOND DRAINAGE BASIN.

The plateau region northward of Lone Mountain ridge, westward of First avenue and southwestward of the Presidio ridge, is drained by Lobos Creek. All of Richmond lies within the watershed of this creek. This watershed, with the Ocean frontage from Fort Point to Point Lobos, is included within the limits of the Lobos Creek drainage basin.

Mountain Lake is a feature of this basin. It lies just within the Government Reservation. The natural drainage channel of this basin is Lobos Creek, a stream of small though perennial flow, yet of sufficient importance to have been, until recently, a source of water supply for the City.

OCEAN BEACH DRAINAGE BASIN.

The Ocean Beach drainage basin, as its name implies, fronts westward upon the Pacific Ocean. Its extent is southward from the Point Lobos ridge to near Laguna de la Merced. It has no natural drainage lines across the irregularly piled up sand drifts, the only well defined water courses being in its southwestern portions, between the hills of the Twin Peak group.

OCEAN VIEW AND LAGUNA DE LA MERCED DRAINAGE BASIN.

Of the Laguna de la Merced drainage basin but little is to be said at this time. It is at present one of the sources of water supply of this City. It is sparsely settled, and is in no immediate need of improved drainage facilities, except in its northeasterly portions, at and near Ocean and Lake View. But its drainage must be taken into consideration in connection with a determination of the methods to be employed in disposing of the sewage from this and the Ocean Beach district.

A considerable portion of the watershed of this district lies south of the County line, and the ultimate plan of disposing of storm-water and sewage in this region must make suitable provision for this district, even though it lies beyond the limits of the City.

BE ER
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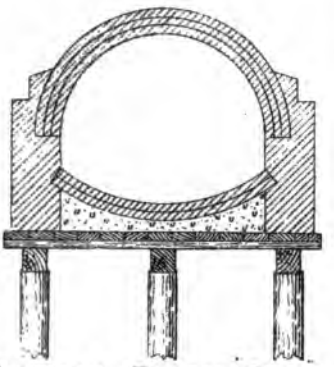
STREETS



BETWEEN FOLSOM STREET
AND SAN BRUNO ROAD

T SEWER

SYSTEM OF SEWERAGE

FOR THE

CITY AND COUNTY OF SAN FRANCISCO

TYPES OF SEWERS NOW IN SERVICE

C. E. GRUNSKY, Civil Engineer in charge

MARSDEN MANSON, C. S. TILTON } Associate Engineers

October 21, 1899

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SECTION IN GOOD GROUND
SECTION IN BAD GROUND

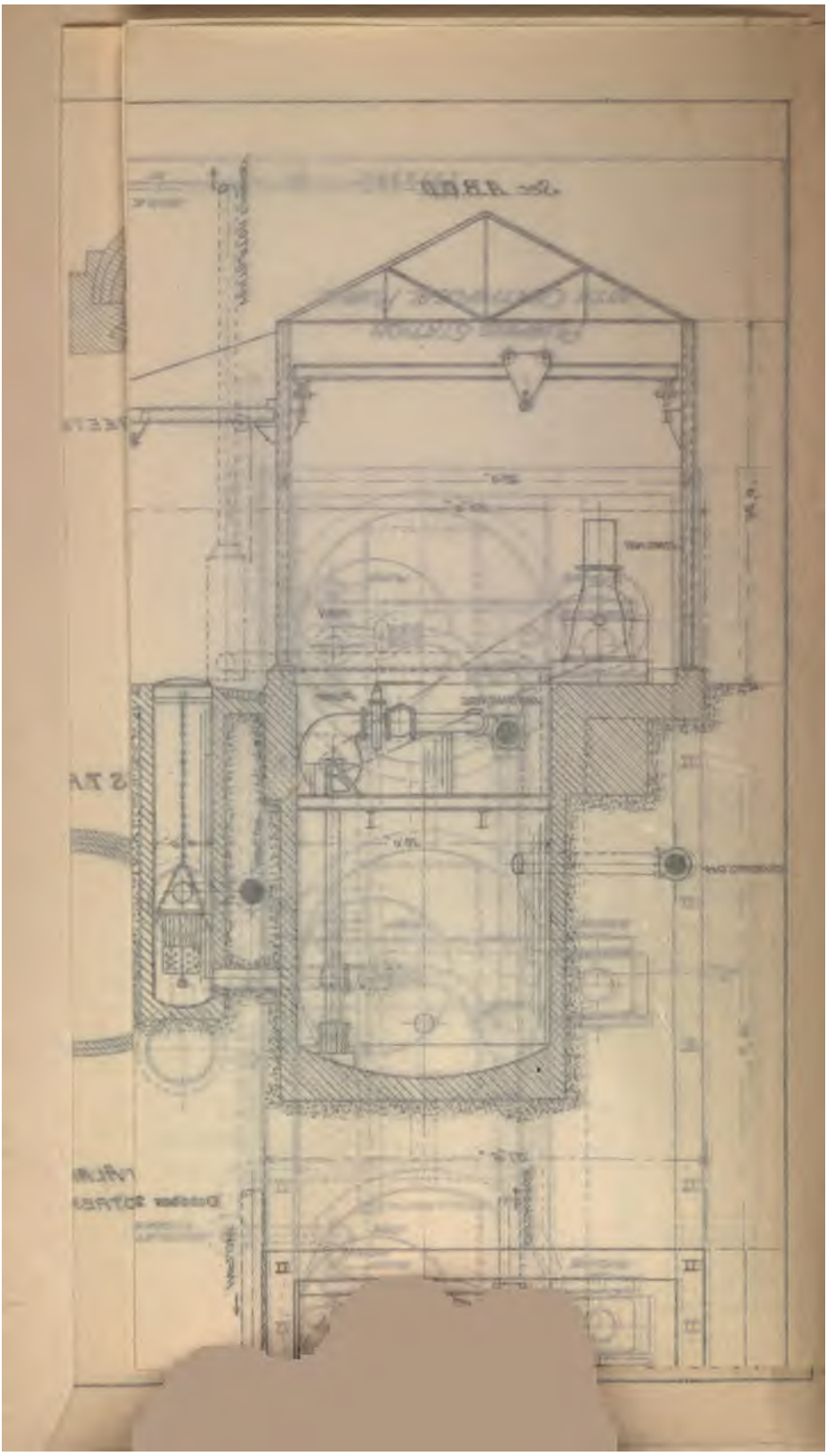
LARGE SEWER OR STORM WATER CONDUIT
ON PILE SUPPORTS

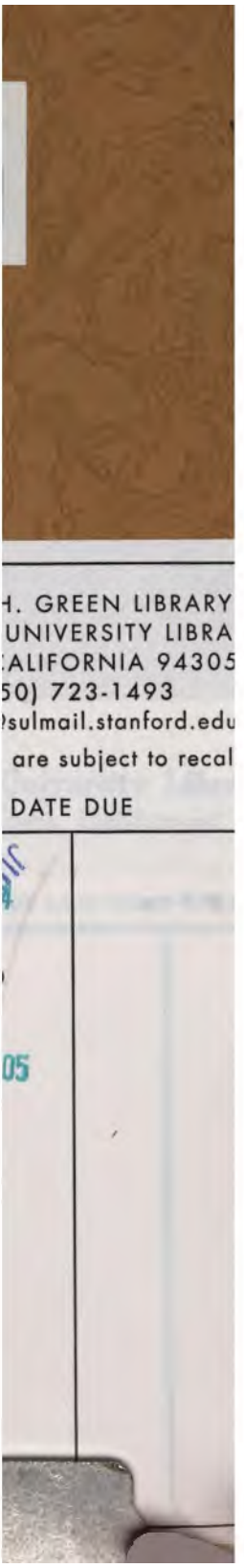
PLAN

EGG SHAPED SEWERS
CIRCULAR SEWERS

LARGE CIRCULAR SEWER
ON PILE SUPPORTS

Plate № 14.

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